A neonate *Antaresia perthensis*, the Pygmy python from Western Australia.
See paper in this issue. (photo by R. Frith).

The fourteen member societies are:

ACT HERPETOLOGICAL ASSOCIATION INC.

Correspondence to:
GPO Box 1335, Canberra, ACT 2601

ADELAIDE SNAKE CATCHERS (INC)

Correspondence to:
PO Box 12, Kent Town, SA 5071

AUSTRALIAN HERPETOLOGICAL SOCIETY (INC)

Correspondence to:
PO Box R79, Royal Exchange,
Sydney, NSW 2000

CAPE YORK HERPETOLOGICAL SOCIETY

Correspondence to:
PO Box 848M, Manunda, QLD 4870

CENTRAL COAST REPTILE AND FROG GROUP

Correspondence to:
PO Box 922, Gosford, NSW 2250

FROG AND TADPOLE STUDY GROUP OF NSW INC.

Correspondence to:
PO Box A2405,
Sydney South, NSW 1235

NEW ZEALAND HERPETOLOGICAL SOCIETY INC.

Correspondence to:
PO Box 33-1187, Takapuna,
Auckland New Zealand

QUEENSLAND REPTILE AND AMPHIBIAN CLUB INC.

Correspondence to:
7 Crowson Lane,
Park Ridge, QLD 4125

REPTILE KEEPERS ASSOCIATION

Correspondence to:
PO Box 98, Gosford, NSW 2250

SOUTH AUSTRALIAN HERPETOLOGY GROUP (INC)

Correspondence to:
c/- South Australian Museum,
North Terrace, Adelaide, SA 5000

TASMANIAN HERPETOLOGICAL SOCIETY

Correspondence to:
273 West Tamar Road,
Riverside, TAS 7250

VICTORIAN HERPETOLOGICAL SOCIETY INC.

Correspondence to:
16 Suspension Street,
Ardeer, VIC 3022

WESTERN AUSTRALIAN SOCIETY OF AMATEUR HERPETOLOGISTS (INC)

Correspondence to:
169 Egina Street,
Mt. Hawthorn, WA 6016

WHYALLA AMATEUR REPTILE KEEPERS ASSOCIATION

Correspondence to:
PO Box 219,
Whyalla, SA 5600

CONTENTS
Volume 28 No 2

HERPETOLOGICAL NOTES

FIELD OBSERVATIONS ON THE SEMI-ARBOREAL PYGOPODIDS
ACLYS CONCINNA (KLUGE 1974) AND *PLETHOLAX GRACILIS* (COPE 1864)

M.J. Bamford, 23 Plover Way, Kingsley, WA, 6026

Pletholax gracilis (the Keeled Legless Lizard) and *Aclys concinna* (the Javelin Legless Lizard) are endemic to near-coastal regions of the mid-west of Western Australia. *P. g. gracilis* occurs between about 29° 30'S and 32° 10'S, while *P. g. edelensis* is restricted to the Shark Bay area around 26°S. The southern race is largely confined to the coastal sandplain where it occurs in *Banksia* woodlands and shrublands, while the northern race has been recorded in open shrublands mixed with hummock grasses on loams and sandy loams, and in coastal heathlands on white sand. *A. concinna* has a very similar distribution, with a southern race (*A. c. concinna*) present in near-coastal woodlands between 29° 20'S and 31° 50'S, and a northern race (*A. c. major*) in *Banksia* shrubland on sand ridges at Shark Bay (Storr *et al.* 1990 and pers. obs).

Although they occur in remnant native vegetation within the city of Perth, both species are poorly known. *P. gracilis* in particular is enigmatic, as specimens are rarely encountered and while the species does occasionally get caught in pitfall traps, little is known of its biology. It is frequently described as being fossorial (eg. Cogger 1992), apparently on the basis of observations on captive specimens (Bush *et al.* 1995), but a number of authors have commented that its morphology is inconsistent with such a lifestyle (eg. Bush *et al.* 1995, Wilson and Knowles 1988). Unlike small, fossorial reptiles such as blind snakes and many skinks, *P. gracilis* is extremely slender, with an adult snout to vent length (SVL) of up to 80 mm in *P. g. gracilis* and up to 90 mm in *P. g. edelensis*, but with a tail up to four times the SVL (Storr *et al.* 1990, Bush *et al.* 1995). The longest and heaviest of 19 specimens collected at Mooliabeenee (31° 20'S,

116° 02'E) had a snout to vent length of 80 mm, a total length of 316 mm and a weight of 2.6g (M. Bamford, unpub. data). Furthermore, both dorsal and ventral scales are keeled, whereas the majority of small, fossorial reptiles have smooth scales to facilitate movement through the soil.

In having keeled scales, *P. gracilis* resembles *A. concinna*, which is slightly larger and a little more heavily built. Bush *et al.* (1995) consider *A. concinna* to be semi-arboreal and report that it has been observed in bushes 2m above the ground. Because of this similarity, it has been suggested that *P. gracilis* might also be semi-arboreal, but the species is rarely observed in the wild and apparently fails to 'perform' in captivity. This suggestion was probably first made by Davidge (1979) who observed that several of the few *P. gracilis* she caught in pitfalls had recently dropped their tails, which is unusual for the species. Without their tails, individual *P. gracilis* are very small lizards and Davidge hypothesised that they were then forced to travel on the ground, making them vulnerable to pitfall traps. The suggestion that *P. gracilis* might be semi-arboreal has also been made by Greer (1989), Shea and Peterson (1993), and Shea (1993), but these authors also describe the species as partly fossorial.

During several studies of small vertebrates in *Banksia* woodlands north of Perth, small numbers of *P. gracilis* and *A. concinna* have been caught in pitfall traps (Bamford 1986, Bamford and Bamford 1997). At Mooliabeenee, a total of 25 *P. gracilis* (out of 1107 individual reptiles of 32 species) were caught from 1983 to 1986, while at Cooljarloo (30° 27'S, 115° 25'E), 3 *P. gracilis* (out of 3213 individual reptiles of 25 species) were caught

from 1989 to 1991. The higher proportion of *P. gracilis* in total reptile captures at Mooliabeenee does not suggest that the species was more common there, as different types of pitfall traps were used at the two sites. Furthermore, understorey vegetation at Cooljarloo was denser than at Mooliabeenee, so a small, arboreal reptile might be more susceptible to pitfall traps at the latter site. While these capture rates suggest that *P. gracilis* was a minor component of the reptile assemblage at both sites, the population density of *P. gracilis* at Cooljarloo was estimated at 5.5 individuals/ha (Bamford and Bamford 1997). This was based on the collection of one inactive individual, found at a depth of 2 cm under loose soil during intensive searching of 1824m^2 of woodland and shrubland. *A. concinna* was not recorded at Mooliabeenee, but 10 were caught in pitfall traps and 7 were found during intensive searching at Cooljarloo. This suggested a population density of *A. concinna* of 38.4 individuals/ha (Bamford and Bamford 1997).

The capture of *P. gracilis* and *A. concinna* in pitfall traps and during intensive searching through soil and leaf litter provides no information on the habitat of the species when active, but active specimens were observed on a number of occasions. At Cooljarloo in particular, specimens of both *A. concinna* and *P. gracilis* were often observed and their behaviour was similar. *P. gracilis* was also observed at Mooliabeenee where *A. concinna* appeared not to be present. Systematic records of such observations were not usually kept, as they were fleeting and identification was difficult, but the highest number seen on any one occasion was 2 probable specimens of *A. concinna* and 3 probable *P. gracilis* seen in shrubland on the edge of a 100 m length of track. During November field work at Cooljarloo, it was normal to see five to ten *P. gracilis* or *A. concinna* in a morning.

As noted above, observations were fleeting and usually consisted of what appeared to be a thin twig lying on top of a bush, 20 cm to nearly 2 m above the ground, suddenly leaping off the bush, across the tops of adjacent bushes and disappearing into the undergrowth. Such observations usually lasted only a couple of seconds and most specimens had travelled several metres in that time. The lizards leapt with a stiff motion, seeming to bounce and spring through the vegetation. In such a brief time, distinguishing *A. concinna* and *P. gracilis* was difficult but was sometimes achieved. The majority of observations were of *A. concinna*, which may just have been because their larger size and heavier build made them more conspicuous, but this is consistent with the different population densities recorded by Bamford and Bamford (1997). Attempts to find lizards after they had leapt were usually unsuccessful, but some specimens of both species did stop at the base of a nearby bush and therefore positive identifications were possible.

These observations of active *A. concinna* and *P. gracilis* were made opportunistically and it would clearly be useful for more systematic records to be kept. The observations clearly indicate, however, that both species are active in low, dense vegetation. They can therefore be described as semi-arboreal with some justification, but the frequent references to them in the literature as also being semi-fossorial or fossorial require explanation. Shea and Petersen (1993) refer to a specimen of *P. gracilis* found within a rotting stump, and to a captive specimen that burrowed into sand in a bucket. Bush et al: (1995) note that the species also buries itself in captivity. In their systematic searching for reptiles, Bamford and Bamford (1997) recorded a single *P. gracilis* as inactive and under 2 cm of soil in a clearing (ie. no litter present), while all seven specimens of *A. concinna* were inactive and beneath litter (ie. on the litter/soil interface). However, while it is clear that *P. gracilis* does burrow, it may only do so to shelter when inactive, in much the same way as it would appear *A. concinna* burrows beneath litter to shelter. Reptiles which would not normally be described as fossorial were found by Bamford and Bamford (1997) buried in soil, including *Morethia obscura* and *Ctenotus fallens* (Scin-

cidae), *Tympanocryptis adelaidensis* (Agamidae) and *Lialis burtonis* (Pygopodidae). All were at depths of 2-10 cm and there was no trace of a burrow.

The term fossorial is normally used to describe animals that live beneath the soil; not for species that burrow into the soil for shelter. However, all observations of subterranean activity by *P. gracilis* appear to relate to inactive specimens or to specimens seeking shelter. There seem to be no observations of burrowing by *A. concinna*, and field observations suggest that it shelters beneath leaf litter (Bamford and Bamford 1997). While fossorial activity is difficult to observe, particularly under natural conditions, the morphology of *P. gracilis* and *A. concinna*, together with observations of their arboreal behaviour, suggest that fossorial may not an appropriate term for these species. They may only burrow to shelter, in common with many other small reptiles.

ACKNOWLEDGMENTS

REFERENCES

Bamford, M.J. 1986. The Dynamics of Small Vertebrates in Relation to Fire in *Banksia* Woodland near Perth, Western Australia. Unpub. Ph.D. Thesis, Murdoch University, Perth.

Bamford, M.J. and Bamford, A.R. 1997. Cooljarloo Environmental Management Programme, Fauna Studies 1996. Unpub. report to Tiwest Joint Venture, Perth.

Bush, B., Maryan, B., Browne-Cooper, R. and Robinson, D. 1995. A Guide to the Frogs and Reptiles of the Perth Region. University of Western Australia Press, Perth.

Cogger, H.G. 1992. Reptiles and Amphibians of Australia. 5th edition. Reed Books, Chatswood.

Davidge, C. 1979. The herpetofaunal community of a *Banksia* woodland near Perth, Western Australia. Unpub. Ph.D. Thesis, Murdoch University, Perth.

Storr, G.M., Smith, L.A. and Johnstone, R.E. 1990. Lizards of Western Australia III. Geckoes and Pygopods. W.A. Museum, Perth.

Shea, G.M. and Petersen, M. 1993. Notes on the biology of the genus *Pletholax* Cope (Squamata: Pygopodidae). Rec. West. Aust. Museum. 16: 419-425.

Shea, G.M. 1993. Family Pygopodidae. Pp.234-239 in Glasby, C.J., Ross, G.J.B. and Beesley, P.L. (eds). Fauna of Australia. Vol. 2A Amphibia and Reptilia. Australian Government Publishing Service, Canberra.

Wilson, S.K. and Knowles, D.G. 1988. Australia's Reptiles: a photographic reference to the terrestrial reptiles of Australia. Collins, Sydney.

PREY-SCARING BY VISUAL PURSUIT PREDATORS:
A NEW USE FOR TAIL-WAVING IN SNAKES

John D. Scanlon
Department of Biological Sciences, Monash University
Clayton, VIC 3168

INTRODUCTION

Tail-waving occurs in a wide range of snake taxa, and is frequently associated with either antipredator defence or prey-luring. In its simplest form, raising of the tail may be a preparation for defensive use of the noxious cloacal scent glands possessed by all snakes (cf. Greene 1988). This threat is amplified in many taxa by the presence of bright or contrasting colours in the anal or subcaudal region, which are apparently aposematic (e.g. *Cylindrophis, Exiliboa, Diadophis,* Parker and Grandison 1977, Bogert 1968). The noxious threat may also be supplemented or supplanted by an additional defensive function of the tail: diversion of a predator's attention away from the more vulnerable head of the snake. In short-tailed fossorial snakes, caudal head-mimicry can provide a defensive diversion while the actual head is hidden under body coils or commences burrowing (e.g. uropeltids, erycines, scolecophidians; Parker and Grandison 1977, Pough 1988).

Any display directed at another individual can also be classified as 'honest' or 'deceptive' (cf. Maynard Smith 1991). Thus in the examples just noted, simple tail-raising is an honest threat (backed up by the cloacal secretions), but becomes deceptive when accompanied by mimicry of the snake's head or of the colour pattern of a more noxious animal (centipede, coral snake etc.).

Caudal luring may have developed by a preexisting defensive behaviour being co-opted for a new deceptive function. In most species where it occurs it is restricted to juveniles (Leal and Thomas 1994), and usually the tail has a conspicuous pattern while the rest of the snake is camouflaged. Modifica-

tion of caudal pattern and morphology in such snakes may contribute to their overall camouflage, as well as attractiveness of the lure to insectivorous vertebrates. The ambush behaviour of Death Adders (*Acanthophis* spp.; e.g. Carpenter et al. 1978, Chiszar et al. 1990) can be compared to the strategy of deep-sea Angler Fish. It involves the predator remaining mostly still and camouflaged, its head often partly encircled by a coil of the body (hence invisible from ground level), so that the moving lure will appear to be a small and harmless organism attractive to the prey. Similarly, caudal luring is common in pit vipers, so that the modified tail in the Rattlesnakes *Crotalus* may have originated as a specialised deceptive lure (and still performs this role in juveniles of some species), but now functions in adults as an honest threat to potential predators and large herbivores (Brock Fenton and Licht 1990). Runcie (1997) reports body-thrashing by *Acanthophis praelongus* (producing a loud rustling noise among dry leaves), and interprets it as a defensive threat to large mammals, analogous to 'rattling' in *Crotalus*.

In contrast to the widely known mechanisms to deter predators and attract prey, Magnusson (1996) proposes an alternative adaptive advantage of tail-waving (or limb-waving) by lizards during pauses between bouts of locomotion. The proposed function is to stimulate a stalking predator to continue moving while the lizard's head remains still (so that its vision is uninterrupted), thus revealing the predator's location and facilitating avoidance by the lizard. This 'come-on' signal (an honest lure) could operate to the lizard's advantage only where both predator and prey depend on visual detection of motion to

locate each other. Here I report some observations of Australian elapid snakes stalking lizards which suggest that analogous advertisement of its own position (an honest threat) can be of advantage to a predator rather than its potential prey. In particular, tail-waving by stalking snakes regularly stimulates nearby lizards to move (away from the tail rather than towards it) providing a target for visually mediated attack by the snake.

OBSERVATIONS

Drysdalia

The taxonomic concept of the genus *Drysdalia* has been stable for many years (Worrell 1961, Coventry and Rawlinson 1980, Hutchinson 1990). *D. coronata* of southern Western Australia is similar to the other species ecologically (but with a broader diet; Shine 1981) and in superficial aspects of morphology (Coventry and Rawlinson 1980), but phylogenetically somewhat remote (McDowell 1967, Mengden 1985) and is referred to *Elapognathus* by Greer (1997). A male *D.coronata* born in captivity was maintained for over two years (initially in R. Shine's laboratory at the University of Sydney, later by the author in Sydney and Canberra), growing from SVL= 124mm. at birth in February 1985, to 250mm at 12 months (attempted copulation with a female *Cacophis squamulosus* implying sexual maturity at this age) and 310mm. at 24 months. I used a 'naturalistic' setup of a tank containing sand or soil, sclerophyllous leaf-litter, twigs, pieces of bark, wood, rocks (thus a visually and structurally complex space), and a water dish. The main food provided was live skinks, mostly *Lampropholis guichenoti*.

D. coronata, like the other species on which observations are reported below, is a large-eyed, mainly visual hunter, and it is possible for a human observer to judge more or less accurately, from the movements and orientation of the snake's head (and also directly from the eyes, which have a pale ring around the pupil), what is within its field of vision and where its attention is directed. This non-trivial fact makes it possible to distinguish between behaviour directed at unseen prey, visible prey, and at the observer.

Foraging activity would occur at any time of day or night when sufficiently warm, prey being captured by one or more of the following: searching under items of cover, chemosensory trail-following, slow visual stalking, rapid following or striking in response to visible motion (including ambush from under cover), and biting (with or without striking) on tongue contact with immobile prey. Accidental or deliberate release was common after striking, the snake usually tracking the prey, with intense tongue- flicking, after a pause of a few seconds to over a minute. On grasping a skink by the tail, the wriggling autotomised tail was always swallowed immediately, without pausing to envenomate by'chewing', and the chase usually resumed for the rest of the skink ('swallow and follow'). In one case, a skink grasped by the body was swallowed in the same hurried manner to preclude 'escape' of the autotomised tail. In these foraging habits and in being largely diurnal, *D. coronata* resembled *Hemiaspis signata* more than *D. coronoides* and *D. rhodogaster*, which are mainly nocturnal and crepuscular in warm conditions, except for basking in the early morning (pers. obs.). The mother of the *D. coronata* studied here was known to regularly use constriction in subduing skinks (R. Shine, pers. comm.; cf. Shine and Schwaner 1985), but this was never observed in the individual studied (even for relatively large prey such as *Ctenotus taeniolatus* and *Eulamprus tenuis*). The tail of *D. coronata* was more strongly prehensile than in other elapids studied, the snake was a capable climber (e.g. in tussock-grass and bunches of twigs), and tail-waving was observed in several contexts:

(1) At about three months (SVL 145mm, tail 32 mm), the tail was raised and waved fluidly through an arc of 2-3cm for about 10 seconds. This occurred with no skinks present and while the observer slowly approached the

terrarium, and on continued approach the snake suddenly retreated to cover briefly before reemerging to bask. This seems to correspond closely to the 'come-on' (predator-luring) behaviour seen in lizards such as *Lampropholis guichenoti* (cf. Magnusson 1996), and was the only occasion when this snake apparently directed a tail-waving display at the observer (in the role of 'predator').

(2) At four months, during exploratory/foraging behaviour (again with no skinks present) while the snake was partly covered by leaf litter, the tail was raised and shaken rapidly in contact with leaves. This was conspicuous and audible from several metres away, and can be interpreted as either 'broadcast' luring behaviour, or an accidental variant of the following.

(3) On many later occasions (up to and beyond 24 months) when following scent trails or responding to movement of skinks in litter, one or several short bouts of tail-waving would occur when the skink was close, sometimes in direct line of sight, but not moving. Displacement and rustling of leaf-litter was common. Usually the skink began to move away (often explosively) in response to a bout of tail- waving, and the snake followed rapidly and struck. (In captive conditions, strike success may actually have been lowered by this behaviour, as the snake was quite capable of locating and capturing immobile skinks by scent alone, either within refugia or in darkness.)

(4) At 12 months, when placed on a desktop, there was a brief bout of tail-waving just before the snake entered a 'crevice' between papers. This, like the preceding typical case, seems adapted to stimulate hidden prey into motion, although it was similar to luring in not being stimulated by actual presence of prey.

Tail-waving (similar to case 2 above, but without rustling leaves) was seen on two occasions in captive-born juvenile *Drysdalia rhodogaster* during exploration or basking, in the presence of several active siblings but no skinks. Little foraging behaviour has been seen in adults of this species, but no evidence suggests use of tail-waving in other than a 'luring' role.

Demansia

The apparent prey-scaring function of tail-waving is most strongly developed, among species observed, in the genus *Demansia*. Several individuals of *D. psammophis* (from New South Wales and Queensland) and one of *D.* sp. cf. *olivacea* (from north-western Queensland, =*D. ornaticeps* ,*fide* Shea pers. comm. 1998) have been observed. Not all stalking episodes involve tail-waving (e.g., not reported by Magnusson 1996) but a wide range of intensity of the behaviour occurs in both species, ranging from slow waving or slight shaking of the raised tail tip while the snake is partly under cover (probable luring behaviour, as in juvenile *Drysdalia*) to twitching, lashing or undulation of the whole tail and posterior part of the trunk while stalking. In the most extreme cases, the tail is moved steadily forward lateral to the head, apparently representing a direct approach to the last known location of the prey (also observed in the field, R. Shine pers. comm.).

It is possible for potential prey to increase their chance of survival, simply by not running away when 'threatened'. For instance, *Saproscincus mustelinus* in the same terrarium with *Drysdalia* or (especially) *Demansia* are able to evade capture for long periods by (a) being active at lower temperatures, and usually in darkness, and (b) responding to nearby snake activity, including tail- waving, by immobility or a very slow creep under cover.

The visual hunting behaviour of *Demansia* spp. is also characterised by the raised posture of the head and neck while foraging. When emerging from a refugium, and for much of the time while foraging, whipsnakes raise the head several cm from the substrate (up to about 4cm in a *D. psammophis* with SVL 270mm, and 10cm or more in larger snakes), sometimes remaining nearly motion-

less for many minutes. The head is frequently tilted up, parallel to the neck, which maintains a cryptic resemblance to a stick. In this 'alert' posture, they respond to motion in the vicinity by either rapid withdrawal under cover (by concertina contraction of the posterior body and tail), head-bobbing, a combination of intermittent bobbing and tail-waving, or the snake may begin stalking immediately if motion of litter continues or prey is sighted. It is not clear whether head- bobbing functions in prey-scaring, or even crypsis (it looks very un-snakelike at first), but its primary role seems to be in improving depth perception; the motion may be more or less smooth or jerky, and purely in a vertical plane or from side to side, varying at different times in an individual (more jerky motion appears to correlate with hunger or excitement). The activity seems to be mainly due to the epaxial musculature of the trunk near where it contacts the ground, the neck itself usually remaining stiff.

Head-bobbing was frequently, and tail-waving sometimes, directed at observers outside the terrarium. The latter may have been either a skink-like defensive display or an anticipatory expression of readiness to feed. In a *D. psammophis* which had been in captivity from June 1988 (SVL 270mm) to February 1991 (520mm) without seeing any *Ctenotus*, presentation of a hand-held *C taeniolatus* outside the glass caused obvious excitement. When the lizard (SVL 65mm) was dropped inside, the snake immediately rushed a distance greater than its own body length, seized the *Ctenotus* by the head, and constricted it with up to seven closely-spaced coils, before orienting and beginning to swallow (one minute after striking). Fully developed constriction was never seen with other prey species, including skinks of similar size such as large *Saproscincus mustelinus*, *Saiphos equalis* and *Hemiergis decresiensis*, and it would appear that the striped *Ctenotus* was more readily recognised as desirable prey than were other species.

Oxyuranus

An observation of tail-waving during stalking is also reported in a captive taipan (*Oxyuranus scutellatus*) approximately a year old and 1.5m long (Theo Tasoulis, pers. comm.). In this instance, violent lateral motion of the whole tail occurred when the snake apparently lost sight of a mouse it had been pursuing, and the snake's behaviour was interpreted as a sign of 'frustration'. As it was captive-bred and habituated to observation, it seems not to have been a defensive threat, and luring also seems unlikely in this context.

DISCUSSION

Many herpetologists and keepers have seen instances of tail-waving, but it seems our natural inclination is to interpret it as expressing an emotional state rather than performing a function. For example, we may interpret a defensive threat as a symptom of irritation or anger, even if its adaptive function is to distract attention from the snake's head to allow sudden escape. These interpretations are by no means contradictory (cf. Pinker 1997), but the discussion here will be in terms of function and evolution.

In encounters between predator and prey, the position of advantage is to maintain a 'fix' on the other's position and movements while one's own are undetected. In cases of diurnal, visually mediated encounters, this advantage can be preserved by remaining still except while the other is moving. Thus, tail-waving or other displays by a lizard can function as a lure ('come-on') to make a visual predator move, giving away its position and compromising its ability to see, so that the lizard can run away (Magnusson 1996). When only the tail moves, there may be an element of deception in that the information the lizard gives away on its position is imprecise (very much so in the case of an automised tail), but generally this display is an honest lure. The usual interpretation of tail-waving as a diversion or 'sacrifice' (offering a detachable, regenerable organ in place of its whole self) can not apply to arm-waving, and even in tail-waving might not represent the main selective advantage, but rather a second line of defence. For example, both

limb-waving (circumduction) and head-bob-bing in the agamid *Lophognathus longirostris* show characteristics expected for 'come-on' signals: they are directed toward human observers in the absence of conspecifics and 'were always followed by fleeing to cover upon movement of the observer' (Blamires 1998). Other interpretations of such displays (as 'threat', 'distraction' or 'recognition' signals, Blamires 1988) do not seem to explain either the effect on the observer or the displaying lizard's next move.

In the asymmetric situation of predator-prey interactions, the counterpart of the 'come-on' tactic is tail-waving by the stalking predator, as a form of honest threat with the effect of making the prey try to run away, and thus give away its position. In the species where this behaviour is reported here, the tail is medium to long and tapering, becoming gradually paler toward the tip but lacking a contrasting pattern. In contrast to luring, the proposed function of 'prey-scaring' does not require specialised or cryptic external morphology; indeed its effectiveness is consistent with the prey readily recognising and attempting to avoid the predator. Thus, it would usually be of value only for searching foragers capable of rapid pursuit. This was the case in the *D. coronata* studied, at least in the confines of a terrarium, but applies particularly to fast-moving, large-eyed species such as the whipsnakes and taipan. But as with the case of the lizard tail-waving as a lure, immobility or crypsis of the snake's head while the tail moves introduces a 'deception' factor (imprecise spatial information), making it possible for the prey's flight to lead it closer to the predator's jaws.

Tail-waving as a lure, which occurs in *Acanthophis* at all ages (Carpenter et al. 1978, Chiszar et al. 1990), may be restricted to juveniles in species of *Drysdalia* and *Demansia*, and probably occurs in other elapids where it has not yet been reported (cf. Leal and Thomas 1994). There is usually no ambiguity whether tail-waving by a snake towards another animal operates as a threat or a lure: it induces either repulsion or attraction. However, there may be a continuum between the

two functions, in that an equivalent commotion could both attract prey at longer range and stimulate escape attempts once the predator was detected. It is worth asking whether body thrashing in *Acanthophis*, interpreted by Runcie (1997) as a threat, might actually attract some types of prey (as well as nocturnal herpetologists). For signals, especially sounds, broadcast to a considerable distance, the distinction between threat and lure is made by the target animal; such a signal is an honest advertisement (barring such cases as vocal mimicry which will rarely apply to snakes), but may be difficult to read.

While Whipsnakes feed opportunistically on various lizards and frogs (Shine 1980), they appear to have coevolved with skinks of the genus *Ctenotus* in an 'arms race' of high speed (analogous to cheetahs and gazelles) and thermal tolerance. The observations on *D. psammophis* reported above suggest a pre-existing (possibly innate) preferential search image for striped skinks, and experiments could easily be performed to test this hypothesis.

Like other aspects of behaviour, those reported here may be subject to considerable individual and ontogenetic variation, but can also contribute to understanding of the ecology and evolution of the lineages in which they occur. For example, we may ask whether caudal prey-scaring behaviour evolved separately in each lineage where it is observed, perhaps as a modification of pre-existing luring behaviour in juveniles, or if it occurs more generally in the Australian elapid radiation. In order to test such hypotheses of ecological and evolutionary patterns, information on the development and context-dependence of behaviour in many other species is required, but much of this information may already exist in the unpublished notes of reptile keepers.

ACKNOWLEDGMENTS

comments on early drafts.

Special thanks to Russell (Drysdalia) who taught me so much.

REFERENCES

Blamires, S.J. 1998. Circumduction and head-bobbing in the agamid lizard Lophognathus longirostris. Herpetofauna 28: 51-52.

Bogert, C. M. 1968. A new genus and species of dwarf boa from southern Mexico. American Museum Novitates 2354: 1-38.

Brock Fenton, M., and L.E. Licht. 1990. Why Rattle Snake? Journal of Herpetology 24:274-279.

Carpenter, C.C., J.B. Murphy, and G.C. Carpenter. 1978. Tail luring in the death adder, Acanthophis antarcticus (Reptilia, Serpentes, Elapidae). Journal of Herpetology 12:574-577.

Chiszar, D., D. Boyer, R. Lee, J.B. Murphy, and C.W. Radcliffe. 1990. Caudal luring in the southern death adder, Acanthophis antarcticus. Journal of Herpetology 24: 253-260.

Coventry, A.J., and P.A. Rawlinson. 1980. Taxonomic revision of the elapid snake genus Drysdalia Worrell, 1961. Memoirs of the National Museum of Victoria 41: 65-79.

Greene, H.W. 1988. Antipredator mechanisms in reptiles. Pages 1-152 in C. Gans and R.B. Huey, ed. Biology of the Reptilia, Vol. 16, Ecology B. Alan R. Liss, Inc., New York.

Greer, A.E. 1997. The Biology and Evolution of Australian Snakes. Surrey Beatty & Sons, Chipping Norton.

Hutchinson, M.N. 1990. The generic classification of the Australian terrestrial elapid snakes. Memoirs of the Queensland Museum 29: 397-405.

Leal, M., and R. Thomas. 1994. Notes on the feeding behaviour and caudal luring by juvenile Alsophis portoricensis (Serpentes: Colubridae). Journal of Herpetology 28: 126-128.

Magnusson, W.E. 1996. Tail and hand waves: a come-on for predators? Herpetological Review 27: 60.

Maynard Smith, J. 1991. Honest signalling: the Philip Sydney game. Animal Behaviour 42: 1034-1035.

McDowell, S.B. 1967. Aspidomorphus, a genus of New Guinea snakes of the family Elapidae, with notes on related genera. Journal of Zoology, London 151: 497-543.

Mengden, G.A. 1985. Australian elapid phylogeny: a summary of the chromosomal and electrophoretic data. Pages 185 - 192 in G. Grigg, R. Shine and H. Ehmann, ed. Biology of Australasian Frogs and Reptiles. Surrey Beatty & Sons, Chipping Norton/Royal Zoological Society of New South Wales, Sydney.

Parker, H.W. and A.G.C. Grandison. 1977. Snakes: a natural history. 2nd Ed. University of Queensland Press, St Lucia.

Pinker, S. 1997. How the Mind Works. Penguin, Harmondsworth, Middlesex.

Pough, F.H. 1988. Mimicry and related phenomena. Pages 153-234 in C. Gans and R.B. Huey, ed. Biology of the Reptilia, Vol. 16, Ecology B. Alan R. Liss, Inc., New York.

Runcie, M.J. 1997. Defensive behaviour in the Death Adder Acanthophis praelongus. Herpetofauna 27: 52.

Shine, R. 1980. Ecology of eastern Australian whipsnakes of the genus Demansia. Journal of Herpetology 14: 381-389.

Shine, R. 1981. Venomous snakes in cold climates: ecology of the Australian genus Drysdalia (Serpentes: Elapidae). Copeia 1981: 14-25

Shine, R. and T.D. Schwaner. 1985. Prey constriction by venomous snakes: a review, and new data on Australian species. Copeia 1985: 1067-1071.

Worrell, E. 1961. Herpetological name changes. Western Australian Naturalist 8: 18-27.

REPORT ON THE BITE OF A CURL SNAKE (*SUTA SUTA*)

Michael Anthony
PO Box 523M
Manunda, Qld, 4870

INTRODUCTION

On 24.12.1995, I incurred a bite from a Curl Snake (*Suta suta*), found while spotlighting the road between Mareeba and Mt Molloy, north Queensland at 10.00pm. The specimen was approximately 35cm in length, emaciated, with folds of skin present from half way down the body to the anus.

The bite occurred while attempting to pin the head of the snake with the index and middle fingers; the failure of this rather foolish attempt resulted in the snake turning and biting the base of the right little finger. Both fangs entered the skin and the snake 'chewed' at the bite site.

EFFECTS OF THE BITE

There was an instant stinging sensation followed by minor swelling within minutes of the bite, as I had previously experienced with bites from other small elapid snakes (see Figure 1).

First aid included first washing, then squeezing and sucking the site of the bite for about a minute. A constrictive bandage kept in the vehicle was considered but decided against as the bite seemed inconsequential and no different from those previously incurred.

I continued to drive along the road looking for reptiles with only a slight increase in swelling and numbness at the bite site, symptoms that I had experienced before without any farther complications.

By approximately 10.20pm an itching sensation began on the forearm of the bitten limb before spreading to first one armpit then the other. By 10.40pm an intense itching, stinging feeling had spread all over the body, breaking out on different parts of the body (ie. knees, head, neck, torso, groin) at different times. After some intense scratching I decided to stop before I broke the skin and tried to bear the itch, which worked for the most part; occasionally an unbearable itch would be scratched automatically. At the same time as the worst of the itching began, a slight numbness and swelling of a small area of the upper lip was felt. Over the next 10 minutes this same feeling spread over the whole of the lips, the sides of the nose and the forehead. About this time I began to suspect the possibility of an allergic reaction as the last bite I had incurred was 3 years previously on the same digit, by a snake in the same genus (*S. punctata*).

At about 11.15pm the itching subsided in intensity. At around the same time a slight swelling of the throat made swallowing moderately difficult. Concurrent with this was a feeling of tightness in the chest. This appeared to be, or led to, a form of indigestion. Forced belching assisted in improving this condition.

The itching, although still present, was much less intense by about 11.30pm and I began to feel a distinct general improvement with only a slight headache and the feeling of tightness in the chest persisting. As these symptoms subsided I noticed pain and swelling in the lymph glands.

Just before midnight, a wave of intense weakness flooded over me and I was forced to pull over, feeling very faint. As it was raining, I decided to get out of the car and stand out in the cool rain for a minute. I struggled out of the vehicle and leant against the side of the

car in the rain which revived me to some degree. I now had an intense thirst and attempted to get into the back of the vehicle to the esky containing a 2 litre bottle of Pepsi Max. This movement caused another wave of faintness to wash over me and I again leant against the side of the vehicle, with pulse racing. After one more attempt at getting into the back of the car and again feeling extremely faint, I managed to reach the bottle. Once recovered from this last physical movement I drank some Pepsi and felt an immediate improvement!

After resting for a few minutes I returned to the driver's seat and took a few deep breaths, before continuing the journey, still feeling slightly faint but much better. A steady improvement began and by about 12.15am I was feeling vastly improved, with no new symptoms.

I arrived home about an hour later and had a shower, having decided not to go to hospital due to the considerable improvement in my condition. Swelling persisted in the bitten finger, the side of the bitten hand to the knuckle of the ring finger, the lymph glands, part of the upper lip, and part of the penis. A rash had formed in the groin. At 2.10am a slight itchiness persisted.

At 10.00am on 25.12.95 1 was still experiencing occasional slight itching on the hand and forearm. The swelling on the hand had increased to the knuckle of the index finger, while the swelling in the lymph glands was reduced, and swelling elsewhere had completely abated. Urine was observed to be slightly brownish.

By 1.30am on 26.12 the swelling of the hand had decreased but I was still unable to clench a fist. There was still occasional itching of the hand and tenderness at the bite site. Only minor swelling persisted in the lymph glands. Urine was pale yellow.

By 11.40am the swelling of the hand had decreased to the stage where I could close the fist and all other symptoms had disappeared.

By the following morning (27.12.95) all symptoms had disappeared and no after effects have been experienced to this day (apart from a wariness of Curl Snakes and the discontinuation of using one's hand to pin the head of small elapids).

DISCUSSION

This particular bite was the most severe I had ever experienced. A previous bite from a 40 cm, healthy S.punctata involved two bites while attempting to manouevre it into a better position for photography and only the initial symptoms described for this bite were experienced (initial stinging sensation, swelling and slight pain at the bite site). The most painful bite was that from a I metre D. psammophis on the same finger, while force-feeding it a small skink. However, these were only local effects.

A number of factors may have led to this latest bite being being so severe.

Firstly, S.suta are known to have potent venom.

Secondly, the individual snake was very thin indicating that it may not have fed for some time and therefore may have had a large amount of venom stored.

Thirdly, previous bites may have induced an allergy to either the venom of snakes of the genus Suta (as I had sustained previous bites from a snake of this genus) or to snake venom in general, (allergy may not be specific and reactions can be triggered from snakes not previously encountered - Sutherland, 1983). The intense itching described (termed urticaria) is reported as being a symptom of allergic reaction.

This was the third bite on the same finger (1976, 1992, 1995).

Lessons to be learned

Do not take liberties with small elapid species, especially if you have been bitten previously. Looking back at the incident, I feel that due to the vast majority of snakes I deal

with in the tropics being harmless colubrids and pythons, I had minimised my fear of a snake that seemed to be reasonably innocuous. On the rare occasions that I tackle the larger, deadly snakes to be found here I am fully aware of the consequences of incurring a bite. However, my guard was lowered in this case of dealing with a small elapid species.

Because of the dangers of forming allergies to snake venom, the attitude of a herpetologist should be to minimise completely any possibility of being bitten by any elapid species.

REFERENCES

Cogger, H. G. 1996. Reptiles and Amphibians of Australia. Reed, Sydney.

Sutherland, S.K. 1983. Australian Animal Toxins; the creatures, their toxins and care of the poisoned patient. Oxford University Press, Melbourne.

Figure 1. Snakebite History

PERSONAL HISTORY OF SNAKEBITE

Year	Species	Bite site	Symptoms
1975	Rhinoplocephalus nigrescens	unrecorded (hand)	none
1976	Demansia psammophis	little finger right hand	swelling of little and adjacent finger and knuckles. Throbbing pain at bite site. Little finger turned blue around bite site. Pain shooting up arm for approximately I hour
1976	Psuedechis porphyriacus (juv)	unrecorded (hand)	none
1978	Denisonia devisii	unrecorded (hand)	stinging sensation for 1/2 hour, slight swelling at bite site I hour
1992	Suta punctata	little finger right hand	initial stinging sensation, slight pain and numbness persisting for about I hour

EVIDENCE FOR SIDEWINDING IN THE BANDED SEA KRAIT, *LATICAUDA COLUBRINA*

Harold Heatwole[1] and Petah Abbott[2]

[1] Department of Zoology, North Carolina State University, Raleigh, NC 27695-7617, U.S.A
[2] Presbyterian Ladies College, Armidale, N. S. W. 2350

INTRODUCTION

Sidewinding is a type of limbless locomotion involving 'rolling' loops of the body forward, with one portion of the body making static contact with the substrate while another part moves relative to the ground. The long axis of the snake's body is at an oblique angle to the direction of travel (Gans 1962, Gans & Kim 1992). The head and anterior end of the body is raised, then swung sideways across a span of terrain, finally making contact with the ground again in a new position. The snake then progressively elevates it body section by section in a loop that travels posteriorly along the body. At the new point of purchase, the snake bends its neck and as the loop descends the body straightens out along the ground in a track parallel to the initial position. At mid-cycle, the head and neck is in contact with the ground, the midbody looped and elevated and the tail again in contact with the sustrate. Before one loop completes its cycle, another one begins to form. The static body positions of a sidewinding snake leave a characteristic series of parallel tracks at an acute angle to the line of travel. Diagramatically these tracks appear as ////////// with the static head positions being lower left and static tail positions being upper right when the overall direction of travel is from left to right.

OBSERVATIONS

A visit was made to Ilot Araignére, a tiny sand cay near Noumea, New Caledonia, on 30 June 1993 to collect venom of the Banded Sea Krait, *Laticauda colubrina*. Twenty-four individuals were found together in a single cavity in the sand. The island was searched in its entirety and no other snakes were found.

The loose sand of the upper beach bore a series of parallel marks that had the characteristics of sidewinding tracks (Fig. 1). These led on a gentle downward slope from the area at which the snakes were located toward the sea and were not seen anywhere else on the beach. There were pathways of at least eight different individuals.

DISCUSSION

Sidewinding is an adaptation snakes use to traverse smooth surfaces or loose sand that do not provide enough friction for the lateral undulatory locomotion usually employed by snakes. Accordingly, sidewinding has been most often associated with viperid snakes from sandy deserts (Bellairs 1969) although it also has been reported for non-desert colubrids (Mosauer 1930, Jayne 1986, Mori 1993) and a boid (Bustard 1969).

The present paper provides evidence for sidewinding by the Banded Sea Krait. Although *Laticauda colubrina* were not actually observed making the tracks, the facts that (1) the tracks led only from the area inhabited by a large group of sea kraits, and (2) there were no other species of snakes on that tiny island converge as strong evidence that the Banded Sea Krait employs sidewinding when traversing loose sand.

This is the first indication of a laticaudid sidewinding. However, it is not the first record of an aquatic snake doing so. Jayne (1986) noted that the natricine *Nerodia fasciata* (Banded Water Snake) and the homalopsine *Cerberus rynchops* (Bockadam) both sidewinded when placed on sand. The latter was observed to sidewind over tidal mud flats in its natural habitat. Similarly, another marine homalopsine, *Bitia hydroides*, is a

proficient sidewinder over mud (Jayne et al. 1995). Like sand, mud lacks the irregularities that provide purchase for undulatory locomotion.

The suggestion has been made that sidewinding may not be a response to loose substrate, but rather an adaptation for traversing hot surfaces in the desert as it involves temporarily lifting the body off of the hot substrate (Cowles 1956). However, this is unlikely to apply to *L. colubrina*. Most of their traversal of the beach takes place during high tides at night when the sand is cool (Heatwole 1987).

REFERENCES

Bellairs, A., 1969. The Life of Reptiles, vol. 1. Weidenfeld and Nicolson, London. 282pp.

Bustard, H.R., 1969. Defensive behavior and locomotion of the Pacific boa, *Candoia aspera*, with a brief review of head concealment in snakes. Herpetologica 25: 164-170.

Cowles, R.B., 1956. Sidewinding locomotion in snakes. Copeia 1956: 211-214

Gans, C. 1962. Terrestrial locomotion without limbs. Am. Zool. 2(2):167-182.

Gans, C., and Kim, H.L., 1992. Kinematic description of the sidewinding locomotion of four vipers. Israel J. Zool. 38: 9-23.

Heatwole, H., 1987. Sea Snakes. University of New South Wales Press, Kensington. 85 pp.

Jayne, B. C., 1986. Kinematics of terrestrial snake locomotion. Copeia 1986: 915-927.

Jayne, B.C., Ward, T.J., and Voris, H.K., 1995. Morphology, reproduction, and diet of the marine homalopsine snake *Bitia hydroides* in peninsular Malaysia. Copeia 1995(4): 800-808.

Mori, A., 1993. A note on the sidewinding locomotion in two colubrid snakes, *Opisthotropis typica* and *Pseudoxenodon macrops*.The Snake 25(I): 67-70.

Mosauer, W., 1930. A note on the sidewinding locomotion of snakes. The American Naturalist 64: 179-183.

Figure 1. Presumed sidewinding trackways leading from the vicinity of an underground cavity containing 24 individuals of *Laticauda colubrina* to the sea at Ilot Araignere, New Caledonia.

SURVEY OF THE REPTILES AND AMPHIBIANS OF THE ESCARPMENT AND RIVERINE FORESTS NORTH WEST OF NOWRA, NSW.

Michael J. Murphy[1] and Garry Daly[2]
[1] 144 Beryl Street Coffs Harbour NSW 2450 and
[2] C/- North Nowra Post Office NSW 2541

ABSTRACT

A survey of the reptiles and amphibians in the escarpment and riverine forests north-west of Nowra, on the New South Wales south coast, recorded 13 species of frogs and 26 species of reptiles. This included three species listed in the *NSW Threatened Species Conservation Act 1995*; the ground frogs *Heleioporus australiacus* and *Mixophyes balbus*, and the elapid snake *Hoplocephalus bungaroides*. Additional species which may occur in the area are noted. The importance of this herpetofauna at a state, regional and local level is discussed.

INTRODUCTION

Nowra (34°52'S 150°35'E) is located in the southern part of the Sydney Basin biogeographical region (Thackway and Creswell 1995). This paper presents the results of a survey of the reptiles and amphibians of the escarpment and riverine forests north-west of Nowra.

The survey was part of recent work by the authors documenting the herpetofauna of the Nowra area (Murphy 1994; Murphy 1995; Murphy 1997; Daly in prep.). A list of species identified during the survey is presented, and the status, distribution and habitat preferences of each species in the study area described. Additional species which may occur in the study area are listed, based on assessment of regional distribution, local records and potential habitats available.

STUDY AREA

The study area covered a forested area north-west of Nowra, where the southern end of the Illawarra Escarpment (the Cambewarra Range) meets the Shoalhaven River. The altitude of the area varies from 0 to 630 m AHD. The substratum is predominantly Nowra Sandstone, with some Wandrawandian Siltstone and Berry Siltstone.

Four separate study sites were surveyed in the study area (Figure 1). The largest was the Bugong study site (about 2125 ha), followed by the Tallowa study site (about 280 ha), Bangalee study site (about 145 ha), and Cambewarra study site (40 ha).

The general habitat types present in the study area were:

1. Woodland dominated by Scribbly Gum *Eucalyptus sclerophylla* and Red Bloodwood *Corymbia gummifera*.

2. Open forest and tall open forest comprising several associations between Grey Gum *E.punctata*, Sydney Peppermint *E.piperata*, Blue-leaved Stringybark *E. agglomerata*, White Stringybark *E. globoidea*, Grey Ironbark *E. paniculata*, Blue Gum-Bangalay hybrid *E.saligna x botryoides*, Red Bloodwood, Spotted Gum *C. maculata*, Turpentine *Syncarpia glomulifera* and Rough-barked Apple *Angophora floribunda*.

3. Subtropical and Warm Temperate Rainforest.

4. Heathland in areas of shallow soil on the upper laterals of creeks, and along a powerline easement which crossed the study area.

5. Paperbark swamps in the upper catchment of creeks and on river flats.

6. Grassland in areas cleared for grazing and powerline easements.

7. Sandstone cliffs 5 to 40 m in height.

8. Aquatic habitat along the Shoalhaven River and tributaries including the Kangaroo River and Bugong, Kellets, Bangalee and Tapitallee Creeks.

METHODS

The survey was done between July 1994 and October 1995, and was part of a survey of all vertebrate fauna in the study area (Daly and Murphy 1996). One of us (MJM) visited the Bugong study site on 48 days and 14 nights between July 1994 and March 1995, the Bangalee study site on 17 days and 8 nights between December 1994 and April 1995, and the Tallowa study site on 13 days and 2 nights between January 1995 and October 1995. GD accompanied MJM on 14 of these visits. The Cambewarra study site was the residence of one of us, and opportunistic surveying for herpetofauna there was done by GD throughout the period of the study.

All habitat types present in each of the four study sites were surveyed. Survey methods involved direct observation of diurnally active animals while walking or slowly driving through the area, active searching (lifting rocks, logs and rubbish), spotlighting at night with 50 watt spotlights for nocturnally active species, listening for frog calls, identification based on tadpole morphology, and examination of road-killed animals.

The status of species in the study area is presented in this paper as rare (single record during the survey or only recorded previous to survey), uncommon (between two and 10 records during survey), common (between 11 and 30 records) or abundant (more than 30 records). The nomenclature in this paper follows Cogger (1996).

RESULTS

Thirteen species of frogs (two families)(Table 1) and 26 species of reptiles (eight families)(Table 2) were recorded in the study area. Four families, the tree frogs (seven species), ground frogs (six species), skinks (11 species) and elapid snakes (eight species), comprised the majority of the herpetofauna, representing 82% of the species recorded.

The greatest number of species was recorded at Bugong (32 species), followed by Cambewarra (27 species), Tallowa (20 species) and Bangalee (18 species).

The richest habitats in terms of herpetofaunal species diversity were open forest (32 species) and grassland (19 species). The poorest habitat (escarpment with six species) supported specialist species found in few other habitats.

Based on the frequency criteria, two species were abundant in the study area, 10 species were common, 16 species were uncommon, and 11 species were rare. The two abundant species were *Crinia signifera* and *Eulamprus quoyii*. Rare species included *Litoria tyleri*, *Mixophyes balbus*, *Eulamprus tenuis* and *Ramphotyphlops nigrescens*.

Information on six additional species (one species of frog and five species of reptiles) which may also occur in the study area, based on consideration of range, local records and available habitat, is summarised in Table 3. All of these species are uncommon to rare in the Nowra area.

DISCUSSION

The study area had a high species diversity of reptiles and amphibians. This diversity is a result of the study area occurring within a large, continuous area of native forest with a wide range of herpetofaunal microhabitats provided by different vegetation communities, rivers and creeks, and escarpment and rocky areas.

The high herpetofaunal species diversity was also related to the area's location in the overlap between the herpetofaunal communities of the ranges to the west and the coastal areas to the east. Species typical of the ranges included *Litoria citropa*, *Ramphotyphlops nigrescens* and *Drysdalia rhodogaster*. Coastal species included *Litoria tyleri* and *Eulamprus tenuis*.

Comparison of the results of this study with recent surveys elsewhere in the Nowra area

TABLE 1

Status, distribution and habitat preferences of amphibians recorded in the study area.

(Study site: 1 Bugong, 2 = Bangalee, 3 = Cambewarra, 4 = Tallowa.)

(Note: p = recorded previous to survey). Habitat: W = woodland, H =heathland, 0 = open forest,

R = rainforest, P = paperbark swamp, G = grassland, C = creeks and rivers.

Status: R =rare, U = uncommon, C = common, A = abundant).

	STUDY SITE				HABITAT							STATUS IN
---	1	2	3	4	W	H	O	R	P	G	C	STUDY AREA
AMPHIBIA												
Hylidae												
Blue Mountains Tree Frog *Litoria citropa*	•	p	•					•	•		•	U
Bleating Tree Frog *Litoria dentata*	•	•	•	•	•	•	•			•		C
Lesueur's Frog *Litoria lesueuri*	•		•	•			•	•		•	•	C
Peron's Tree Frog *Litoria peronii*	•	•	•	•	•	•	•		•	•		C
Leaf Green Tree Frog *Litoria phyllochroa*	•	•	•	•	•	•	•		•			C
Tyler's Tree Frog *Litoria tyleri*		p							•			R
Verreaux's Tree Frog *Litoria verreauxii verreauxii*	•		•	•	•	•	•			•		C
Myobatrachidae												
Common Froglet *Crinia signifera*	•	•	•	•	•	•	•			•	•	A
Giant Burrowing Frog *Heleioporus australiacus*[1]	•						•					U
Brown-striped Frog *Limnodynastes peronii*	•	•	•	•			•		•	•	•	C
Stuttering Frog *Mixophyes balbus*[1]	•						•				•	R
Bibron's Toadlet *Pseudophryne bibronii*	•	•		•	•				•			U
Tyler's Toadlet *Uperoleia tyleri*	•						•		•			U
TOTALS	12	8	8	8	6	5	10	2	7	6	5	

[1] vulnerable species listed in NSW *Threatened Species Conservation Act 1995*

showed that the north-west Nowra escarpment and riverine forests have a particularly rich and significant herpetofauna. The 39 species recorded in this study compared with 26 species (including one marine species) at Seven Mile Beach National Park (Murphy 1994), 29 species at Bomaderry Creek Bushland (Murphy 1997), 29 species at Beecroft Peninsula, Jervis Bay (Daly in press), and 35 species (including three marine species) at Bhewherre Peninsula, Jervis Bay (Daly in prep). Further south, an extensive survey of the herpetofauna of the coastal forests near Bega, NSW by Lunney and Barker (1986) recorded 33 species (including one marine species).

A number of species recorded were of conservation significance. *Hoplocephalus bungaroides* is listed as endangered in both the Commonwealth *Endangered Species Protection Act 1992* and the NSW *Threatened Species Conservation Act 1995* (TSC Act). *Heleioporus australiacus* and *Mixophyes balbus* are listed as vulnerable in the TSC Act. The record of *M. balbus* is one of few recent records of this species on the NSW south coast (Ehmann 1997; Lemckert *et al.* 1997). *Varanus rosenbergi*, considered to potentially occur in the study area, is also listed as vulnerable in the TSC Act. Details concerning the records of threatened species in the study area have been published previously (Daly 1996; Murphy 1996; Daly 1998).

Pseudophryne bibronii, recorded at three of the four study sites, is apparently declining in NSW and is of conservation concern (Osborne 1990; Mahony 1993; Tyler 1994; Ehmann 1997). A number of species recorded, including *Oedura lesueurii*, *Cryptoblepharus virgatus*, *Nannoscincus maccoyi*, *Pseudemoia platynota* and *Ramphotyphlops nigrescens*, are considered locally significant as they are uncommon in the Nowra area. Other species and subspecies are close to their known distributional limits at Nowra, including *Demansia psammophis* (Murphy 1997), *Hemiaspis signata* (Murphy and Daly 1997), and *Physignathus lesueurii howittii* (Swan 1990).

The study area is part of a regional wildlife corridor system identified by the NSW Department of Environment and Planning

TABLE 2

Status, distribution and habitat preferences of reptiles recorded in the study area.

(Study site: 1 Bugong, 2 = Bangalee, 3 = Cambewarra, 4 = Tallowa.
(Note: p = recorded previous to survey). Habitat: W = woodland, H =heathland, 0 = open forest,
R = rainforest, P = paperbark swamp, G = grassland, E = escarpment, C = creeks and rivers.
Status: R =rare, U = uncommon, C = common, A = abundant).

	STUDY SITE				HABITAT								STATUS IN
---	1	2	3	4	W	H	O	R	P	G	E	C	STUDY AREA
REPTILIA													
Chelidae													
Eastern Snake-necked Turtle *Chelodina longicollis*	•	•	p						•			•	U
Gekkonidae													
Lesueur's Velvet Gecko *Oedura lesueurii*	•			•			•				•		U
Agamidae													
Jacky Lizard *Amphibolurus muricatus*	•	•	•	•	•	•	•			•			U
Gippsland Water Dragon *Physignathus lesueurii howittii*	•	•	•	•			•	•	•				C
Varanidae													
Lace Monitor *Varanus varius*	•		•	•	•		•						U
Scincidae													
Fence Skink *Cryptoblepharus virgatus*	•			•			•				•		U
Copper-tailed Skink *Ctenotus taeniolatus*	•	•			•	•	•						C
Mainland She-oak Skink *Cyclodomorphus michaeli*			•							•			R
Eastern Water Skink *Eulamprus quoyii*	•	•	•	•		•	•	•	•	•		•	A
Barred-sided Skink *Eulamprus tenuis*			•				•						R
Grass Skink *Lampropholis delicata*	•	•	•	•			•	•	•	•			C
Garden Skink *Lampropholis guechenoti*	•		•			•	•			•			U
Maccoy's Skink *Nannoscincus maccoyi*	•	p	p				•	•					R
Red-throated Skink *Pseudemoia platynota*	•			•			•				•		U
Weasel Skink *Saproscincus mustelinus*	•	•	•					•	•	•			U
Common Bluetongue *Tiliqua scincoides*			•				•			•			R
Typhlopidae													
Blind Snake *Ramphotyphlops nigrescens*	•						•						R
Boidae													
Diamond Python *Morelia spilota spilota*	•	•	•	•			•	•		•	•		U
Elapidae													
Golden-crowned Snake *Cacophis squamulosus*		•					•						R
Yellow-faced Whipsnake *Demansia psammophis*	p						•						R
Blue Mountains Crowned Snake *Drysdalia rhodogaster*	•						•			•			U
Marsh Snake *Hemiaspis signata*			•								•		R
Broad-headed Snake *Hoplocephalus bungaroides*[2]	•			•			•				•		U
Eastern Tiger Snake *Notechis scutatus*			•				•			•			R
Red-bellied Black Snake *Pseudechis porphyriacus*	•	•	•	•	•		•	•		•		•	U
Eastern Small-eyed Snake *Rhinoplocephalus nigrescens*	•	•				•	•			•			C
TOTALS	20	10	19	12	5	6	22	7	4	13	6	4	

[2] endangered species listed in NSW *Threatened Species Conservation Act 1995*

(1986) (now the NSW Department of Urban Affairs and Planning). Protection of these corridors is necessary to maintain the long-term viability of local and regional wildlife populations.

This paper has documented 39 known and six potential species of herpetofauna in the escarpment and riverine forests north-west of Nowra, and discussed the importance of this herpetofauna at a State, regional and local level. The protection of wildlife and habitat values should be a priority in land management decisions for the area.

ACKNOWLEDGMENTS

TABLE 3

Additional species which may occur in the study area.

(Potential habitat: W = woodland, H = heathland, 0 = open forest,
P = paperbark swamp, G = grassland).

SPECIES	POTENTIAL HABITAT	LOCAL RECORDS
AMPHIBIA		
Hylidae		
Green Tree Frog *Litoria caerulea*	W, 0, P	Bomaderry (Murphy 1997)
		Jervis Bay (Daly in prep)
		Seven Mile Beach (Murphy 1994)
REPTILIA		
Pygopodidae		
Common Scaly-foot *Pygopus lepidopodus*	W, H, 0	Jervis Bay (Daly in prep)
		Kangaroo Valley (Evison pers. comm.)
		Morton National Park (Jenkins 1987)
Varanidae		
Heath Monitor *Varanus rosenbergi*[1]	W, H, 0	Kangaroo Valley (Daly pers. ob.)
		Yalwal (Aust. Museum)[2]
		Yalwal (Goldingay pers. comm.)
Scincidae		
Striped Skink *Ctenotus robustus*	W, H, 0	Bomaderry (Merdith pers. comm.)
		South-west Nowra (German pers. comm.)
Elapidae		
Common Death Adder *Acanthophis antarcticus*	W, H, 0	Jervis Bay (Daly in prep)
		Morton National Park (Jenkins 1987)
		Yalwal (Evison pers. comm.)
Eastern Brown Snake *Pseudonaja textilis*	W, H, 0, G	Jervis Bay (Daly in prep)
		Morton National Park (Jenkins 1987)
		Seven Mile Beach (Murphy 1994)

1 Vulnerable species listed in NSW *Threatened Species Conservation Act 1995*
2 Australian Museum specimen R49193 collected in 1975

REFERENCES

Cogger, H.G. 1996. Reptiles and Amphibians of Australia (5th edition with amendments). Reed Books, Port Melbourne Victoria. 796 pp.

Daly, G. 1996. Observations on the Eastern Owl Frog Heleioporus australiacus (Anura: Myobatrachidae) in southern New South Wales. Herpetofauna 26 (1):33-42.

Daly, G. 1998. Review of the status and assessment of the habitat of the Stuttering Frog *Mixophyes balbus* (Anura: Myobatrachidae) on the south coast of New South Wales. Herpetofauna 28 (1):2-11.
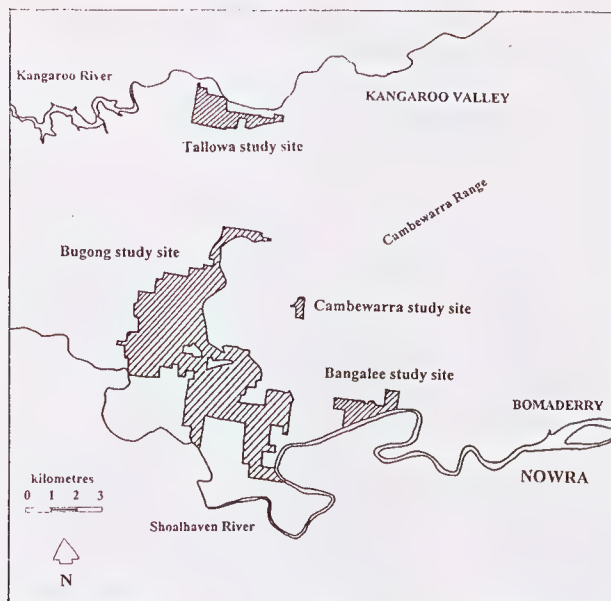
Daly, G. (in prep). Reptiles and amphibians of the Jervis Bay region on the south coast of New South Wales.

Daly, G. and Murphy, M.J. 1996. Fauna audit: select lands, lower Shoalhaven catchment, Shoalhaven City. Unpublished report prepared for the Lower Shoalhaven Catchment Management Committee.

Department of Environment and Planning 1986. Illawarra Regional Environmental Plan No. 1.

Ehmann, H. 1997 (ed). Threatened Frogs of New South Wales: Habitats, Status and Conservation. Frog and Tadpole Study Group of NSW Inc., Sydney, NSW. 237pp

FIGURE 1

Map of the study area north-west of Nowra, NSW

Murphy, M.J. 1994. Reptiles and amphibians of Seven Mile Beach National Park, NSW. Herpetofauna 24(2): 24-30.

Murphy, M.J. 1995. Microsympatry between two species of fossorial skink on the New South Wales south coast. Herpetofauna 25(l): 51-52.

Murphy, M.J. 1996. A possible threat to the Broad headed snake *Hoplocephalus bungaroides*: degradation of habitat by the feral goat *Capra hircus*. Herpetofauna 26 (2): 37-38.

Murphy, M.J. 1997. Survey of the herpetofauna of the Bomaderry Creek urban bushland at Nowra, NSW. Herpetofauna 27(2): 46-48.

Jenkins, R. 1987. Reptile and Amphibian Fauna. Chapter 16 pp. 286-299 in Pigeon House and Beyond. A Guide to the Budawang Range and Environs. The Budawang Committee, Sydney NSW. 306 pp.

Lemckert, F., Potter, M., Smith, B. and Bruest, T. 1997. Recent records of the Southern Barred Frog (*Mixophes balbus*) from the south coast of NSW. Herpetofauna 27 (1): 43-45.

Lunney, D. and Barker, J. 1986. Survey of reptiles and amphibians of the coastal forests near Bega, NSW. Australian Zoologist 22(3): 1-9.

Mahony, M.J. 1993. The status of frogs in the Watagan Mountains area on the central coast of New South Wales. Pages 257-264 in Herpetology in Australia: a diverse discipline. Edited by D. Lunney and D. Ayers. Surrey Beatty & Sons, Sydney NSW.

Murphy, M.J. and Daly, G. 1997. Records of the marsh snake *Hemiaspis signata* near Nowra, NSW: a southern extension of the known range of the species. Herpetofauna 27(2): 33-34.

Osborne, W. 1990. Declining frog populations and extinctions in the Canberra region. Bogong 11 (4): 4-7.

Swan, G. 1990. A Field Guide to the Snakes and Lizards of New South Wales. Three Sisters publications, Winmalee NSW. 224 pp.

Thackway, R. and Creswell, I.D. 1995 (Eds). An interim biogeographic regionalisation for Australia: a framework for establishing the national system of reserves, Version 4.0. Australian Nature Conservation Agency, Canberra. 88 pp.

Tyler, M.J. 1994. Australian Frogs: a Natural History (revised edition). Reed Books, Chatswood, NSW. 192pp.

NOTES ON REPRODUCTION IN CAPTIVE *CTENOTUS SEVERUS* (LACERTILIA: SCINCIDAE)

Glen Gaikhorst Armadale Reptile Centre
Lot 55, Southwest Highway, Wungong 6112

INTRODUCTION

The genus *Ctenotus* is one of Australia's most diverse skink groups containing over 80+species (Cogger 1992). Despite this diversity and abundance in many taxa, they seem to attract little attention from a captive breeding level, resulting in minimal published infornation on them.*Ctenotus severus* is found in the arid midwest and interior of Western Australia on heavy to sandy soils dominated by Acacia woodlands and shrublands (Wilson and Knowles1988). This species prefers rocky areas like granite outcrops where it can be very abundant. In these places it is not uncommon to find several individuals beneath the same rock. In June 1996 (winter), I collected five adult *C. severus* from a granite outcrop near Mount Magnet (28° 04'S 117° 51'E). The species was confirmed by Brad Maryan back at camp(see photo attached). The individual morphometrics are set out in Table 1

As the skinks were housed together, I identified them by using a dot of nail polish on the dorsal side of the body.

HUSBANDRY

The skinks were housed in a 120x30x30cm glass vivarium using yellow sand substrate with a layer of wattle shrub (Acacia) leaf litter. Several slightly raised rocks provided basking and shelter sites. To simulate heating and ultraviolet requirements, I used true-lite power twist tubes and gro-lite bulbs respectively. Both forms of lighting were positioned about 20cm above the closest basking point and were operated for 6-8 hours on a daily basis. The thermal gradient in the vivarium was from 25-30°c. As well as having water provided all the time, I misted twice daily for an extra drinking source. This also improved humidity levels in the enclosure and assisted the skinks with sloughing. Termites, flies, crickets and mealworms were preferred food items being offered twice weekly after dusting with Repcal and Herptivite powders.

BEHAVIOUR

Virtually nothing is known regarding intraspecific behaviour in *Ctenotus* (Greer 1989). All skinks appeared to acclimatize well with no intraspecific aggression being observed until November 1996 (spring). This consisted of minor chases and proximal tail nipping by all

Table 1: Morphometrics on *C.severus*

	SVL	TL	WT	SEX	COLOUR
Skink 1	64mm	172mm	6.0gm	Unknown	No yellow belly
Skink 2	80mm	195mm	8.0gm	Male	Yellow belly
Skink 3	58mm	185mm	3.0gm	Unknown	No Yellow belly
Skink 4	68mm	206mm	6.0gm	Female	Yellow belly
Skink 5	63mm	199mm	5.0gm	Unknown	Yellow belly

the skinks except for skink No 3. Being a sub-adult and probably sexually immature, it played no part in these interactions and was more secretive. No aggression was displayed towards this smaller individual at any time. On some occasions the chasing between the adults was so vigorous it was difficult to observe them. Non aggressive behaviour consisting of head bobbing with an inflated throat region. This was possibly to show the yellow flush on their underside. I interpreted this as a "face off" between two skinks, until one abandoned the confrontation to forage or hide. The speed and agility of Ctenotus remains the same in captivity. After the skinks had obtained an optimum body temperature they often displayed their acrobatic abilities. They leap from rock to rock using their tail as a propulsion spring for extra distance (I suspect). They often leaped to catch flying insects in their enclosure.

Basking under the light took place first thing in the morning and mid to late afternoon. When basking the skinks usually folded their front and hind legs up onto their bodies exposing the palms, in an effort to control their thermoregulation. While doing this the skinks tended to go into a light dosing sleep. If disturbed while dosing the skinks fled for cover. During the middle of the day the skinks tended to hide away with minimal activity. When the skinks were fed or attempted to be caught they became very excited often winding or twitching their tails.

Under natural conditions, I have observed C. severus excavating a shallow burrow beneath rocks and logs on sandy soil. In the wild more than one skink can be found beneath the same cover, but I have never seen more than one skink per burrow. Taylor 1985 experienced the same occurrence with C. taeniolatus, by seeing many Ctenotus under cover but with only one skink per burrow. In captivity this behaviour is duplcated with a 10- 15cm horizontal burrow being excavated which leads to a main chamber. An interesting observation was the soil plugging of burrow entrances. This was done by all skinks after daytime activity had ceased.

BREEDING

The only mating observed was between skink 2 (male) and skink 4 (female) on 3rd December 1996. Both were twisted onto their sides with aligned vents raised off the ground and intertwined tails. They remained in union for 10- 15 minutes. After noticing the female had become gravid, I removed her on 27th December 1996, into a clic-clac box with a slightly moistened vermiculite and paper towel substrate. Four eggs were laid on 1st January 1997 (24 days from conception to eggs laid). These were immediately removed, weighed and measured (Table 2) and placed in a sealed container on 50% water/vermiculite and incubated at 29.6°c with 66% humidity. The container was aired once daily to allow for egg respiration and visibility. Eggs

Table 2:Egg and hatchling data for Ctenotus severus

EGG		HATCHLING		
Size (mm)	Weight (gm)	SVL (mm)	TL (mm)	Weight(gm)
A. 23x9	0.83	28	98	0.72
B. 19X10	0.80	30	100	0.69
C.18xlO	0.79	28	97	0.61
D.19x8	0.81	29	100	0.66

A and B hatched on 17th February and C and D on the following day, after 48-49 days incubation. Hatchlings were weighed and measured (Fig 1) and transferred to a small glass vivarium with identical heating and lighting as provided for the adults. They commenced feeding the next day on baby crickets and termites. As an experiment some vegetable material (silverbeet, lettuce etc) was offered with only small amounts being eaten. At almost two years of age the young are now the same size as their parents

ACKNOWLEDGEMENTS

Thanks to Brad Maryan for confirming the identification of Ctenotus severus and for the helpful comments during the preparation of the paper.

REFERENCES

Cogger, H.G. 1992. Reptiles and Amphibians of Australia. Reed.

Greer, A.E. 1989. The Biology and Evolution of Australian Lizards.- Surrey Beatty and Sons.

Taylor, J.A. 1985. Burrow construction and utilisation by the lizard Ctenotus taeniolatus. Herpetofauna. 15 (2): 44-470

Wilson, S.K. and Knowles, D.G. 1988. Australia's Reptiles- a Photographic Reference to the Terrestrial Reptiles of Australia. Collins.

Figure 1: Adult *Ctenotus severus*

DIURNAL RETREAT SITES FOR LEAF TAILED GECKOS, PHYLLURUS PLATURUS

Adam Stow,
The Australian Wildlife Park,
Wallgrove Rd, Eastern Creek, N.S.W, 2766.

ABSTRACT

Southern Leaf tailed Geckos (*Phyllurus platurus*) are large, sexually dimorphic nocturnal lizards that utilise rocky crevices as diurnal retreat sites. Captive *Phyllurus* were offered a variety of crevices differing in traits such as width, shape and height, and showed consistent preferences based on these characteristics. The presence of conspecifics also affected the geckos' choice of retreat site, but no preference was evident based on crevice orientation or wet <u>versus</u> dry crevices. *Phyllurus platurus* showed a preference for retreat sites that were narrow and invariable in their width. Sexual size dimorphism was present, with female geckos on average being longer and heavier than the males. No sexually - based divergence was observed in crevice choice, although males could fit into significantly smaller crevices. Ascertaining habitat preferences of *Phyllurus platurus* may assist with understanding the implications of habitat disturbance on more vulnerable taxa.

INTRODUCTION

The distribution of many animal species is restricted to particular habitat types and further confined to specific micro-habitats within that habitat. This kind of specialisation is commonly exhibited by nocturnal species relying on specific diurnal retreat sites (e.g., Schlesinger and Shine, 1994). Information on the criteria used to select such sites can therefore aid in evaluating habitat quality for these animals. As natural habitats are often highly complex, it can be difficult to identify the important habitat-selection cues from among a large number of highly intercorrelated variables. In order to clarify the nature of the cues used to assess the suitability of a retreat site, laboratory trials allow a controlled environment in which the significance of a single habitat characteristic can be determined.

The species I studied is the Southern Leaf tailed gecko (*Phyllurus platurus*). Despite ranking among the longest 5 % of geckos in the world (Doughty and Shine, 1995) and being fairly common around the largest population centre in Australia this species has received little scientific attention. The range of *Phyllurus platurus* is the central coast and ranges of NSW where it inhabits sandstone caves, overhangs and crevices (Cogger, 1992).

Determining the habitat preferences of this large saxicolous lizard is important from a conservation perspective. Although the species in question is not considered rare, the bushland habitat in which it resides has been subject to considerable disturbance. Some of the forms of habitat degradation experienced in this area (such as bush rock collecting) have resulted in a decline in the abundance of various reptile species (e.g., *Hoplocephalus bungaroides*: Shine and Fitzgerald, 1989). The diversity of fauna in these habitats suggests complex interrelationships between species. Thus determining the habitat requirements of common species can be of value in assessing the detrimental impacts of disturbance on more vulnerable taxa.

On the basis of observations in the field and published data on retreat sites used by another saxicolous gecko, *Oedura lesueurii* (sympatric with *Phyllurus platurus*) I identified structural and social components of the habitat that might be significant cues for retreat site selection by these lizards. The geckos were then given a variety of retreat sites to test the hypothesis that *Phyllurus platurus* select retreat sites based on crevice characteristics such as crevice width, orientation and moisture and the presence of conspecifics.

METHODS

Leaf tailed geckos were captured by searching sandstone ridges at night. All specimens used were captured around the northern Sydney suburb of Hornsby. The 19 geckos (13 male, 6 female) used in the experiment ranged from 70 to 100mm snout-vent length (SVL) and weighed between 7 and 22g, none of which were gravid. The lizards were held individually in a bank of cages constructed from sealed marine plywood, allowing for thorough cleaning after use. No heating source was provided in their cages and the ambient temperature ranged between 19-29°C. The trials were conducted in a large glass aquarium 183cm / 60cm / 61cm. The substrate used was river sand. The photoperiod was 12 : 12 and was controlled via the use of staged timers so the light intensity increase / decrease was gradual and therefore offered a more realistic simulation of twilight and dawn. The geckos were fed a variety of invertebrates including black field crickets (Teleogryllus kommodus) and black house spiders (Badumna insignis) and always had access to water.

Quarried sandstone blocks (25cm/14.7cm /5cm) were used to create a variety of crevices. Crevice width was created using perspex squares which were either 1mm thick or 4mm thick. The minimum sized crevice into which a gecko could fit was tested by offering smaller and smaller horizontal crevices until the lizard obviously was struggling to squeeze in. Crevices of an even width offered to the geckos in the trials ranged from 7mm to 15 mm. Crevices of a variable width (15mm at the widest end, tapering to 4mm) were also included. A number of crevices were offered in each trial, with the location of each crevice type in the tank randomised. At the beginning of each trial one gecko was placed in a crevice at 4pm and left in the tank until 9.30 am the next day. The position of the gecko was noted and the rocks were then removed and scrubbed with a brush and water to remove any scent. No heat source was pro-

vided during the trial. Casual observation indicated that the geckos moved around and appeared to explore the tank during the night period.

VARIABLES TESTED

(a) Height above substrate and crevice width

In these trials each gecko was simultaneously offered a choice between a variety of crevices differing only in width and height above the substrate. Crevices that were invariable in their width ranged from the minimum width into which the lizard could fit (M) to a crevice 7mm larger than the minimum (M+7). The constructed crevices ranged between 7mm to 15mm in width. Variable width crevices ranged in width from 15mm to 4mm. Crevices were created in separate positions (ie. not one above another) in the tank. Height above substrate was created by positioning the crevices on top of either 1, 2 or 3 sandstone blocks, therefore giving the crevice height a range of 5, 10 or 15cm above the substrate. Different crevice widths were offered at different heights above the substrate.

(b) Orientation

The geckos were presented with a variety of crevice widths oriented either vertically or horizontally. During any one trial vertical and horizontal orientation was offered at the same crevice width.

(c) Moisture

Wet and dry crevices of identical width (10 mm) were offered to the geckos. A wet crevice was created by submerging the sandstone block under water for a period of 10 minutes prior to commencement of the trial.

(d) Social Interactions

In each trial two geckos were placed in the tank with two horizontally oriented retreat sites (10mm width). The following combinations of lizards were used: (1) Two adult males, (2) Two adult females, (3) One male adult and one female adult.

RESULTS

Minimum Crevice Widths

(1) There was a significant correlation between snout vent length and the minimum sized crevice into which a gecko could fit (ANOVA: R = 0.85, N=19, F = 45.95, P < 0.0001).

(2) Male geckos could fit into significantly smaller crevices than the females (unpaired T = 2.92, N = 19, P = 0.0095). Presumably, this difference is related to the significant difference in size between the male and female geckos. The female geckos were on average longer than the males (mean SVL for females = 91 mm, males = 80 mm) and significantly heavier than the males (T = 2.58, P = 0.02) but not more heavy-bodied, measured as mass/SVL (T = 0.033, P = 0.97).

Crevice Widths Selected.

(1) There was no significant correlation between a gecko's length and the mean crevice width selected (ANOVA: R = 0.37, N = 15, F = 2.03, P = 0.18). There was however a significant trend of heavier bodied geckos selecting larger crevice widths (R = 0.46, N = 15, F = 3.40, P = 0.09, with a two-tailed test, P=0.05, with a one-tailed test).

(2) There was no difference in the chosen crevice width between male and female geckos (mean crevice width 10.14 mm for males, 10.63 mm for females; unpaired T test: DF = 13, T 0.70, P = 0.50), despite the ability of male geckos to fit into smaller crevices than the female: see above.

(3) Geckos preferred larger crevices than the minimum into which they could fit, with lizards choosing a larger than minimum crevice in every trial. A chi-squared test comparing the selection of a larger than minimum crevice width with the expected selection was based on the first trial per lizard to ensure statistical independence (x^2 = 27, IDF, P < 0.0001).

Orientation

Out of 27 trials geckos selected a vertically orientated crevice on 12 occasions and a horizontally oriented crevice on 15 occasions. There was no significant preference for either a horizontal or vertical crevice orientation (x^2 = 0.33, IDF, P > 0.05).

Variable versus Invariable crevice width

Geckos selected crevices of even width (ie. parallel sides) as opposed to crevices of a variable width (14 geckos selected a crevice of even width out of 15 trials; x^2 = 11.27, IDF, P < 0.001)- In this analysis only the first trial with an individual was used to ensure statistical independence.

Wet versus Dry crevices

Geckos did not display any significant preference for a wet versus dry crevice (7 geckos selected a wet crevice, 9 geckos selected a dry crevice; x^2 = 0.6, IDF, P > 0.05).

Height above substrate

The lizards preferred crevices close to the ground. Geckos tended not to select crevices 15cm above the substrate. Indeed, no crevices at this height were selected in 30 trials. Geckos tended to select crevices 5cm high as opposed to 10cm above the substrate. This was significant when all the 30 trials were included (21 geckos selected crevices 5cm above substrate out of 30 trials; x^2 = 4.80, IDF, P < 0.05). However, when the analysis was repeated using only one trial per lizard (to assure statistical independence), this trend was no longer significant (11 geckos selected a crevice 5cm above substrate out of 15 trials; x^2 = 3.27, IDFI, P > 0.05).

Social influences

Geckos consistently chose separate crevices (29 of 37 trials; x^2 = 11.92, IDF, P < 0.001). This avoidance of conspecifics was evident in all combinations of gender used (ie. geckos did not avoid others of the same sex any more than those of the other sex; there were no significant differences between male /

male, female / female and male / female combinations; x^2 = 2.03, 2DF, P > 0.30).

DISCUSSION

Leaf tailed geckos in bushland areas are restricted to rocky areas, usually sandstone. They are relatively common in the Hawkesbury sandstone areas around Sydney. Their diurnal retreat sites in the wild appear to be exclusively confined to rocky crevices amongst sandstone outcrops (e.g., Greer, 1989). This study indicates that the leaf tail gecko is highly selective in respect to retreat site selection. In respect to crevice width the retreat choice may be related to reducing vulnerability to predation and/or enhancing thermoregulatory opportunities. As temperature preferences were not tested during this study only the possible benefits in relation to predation will be discussed. It has been suggested that predators are least likely to gain entry into narrow parallel crevices under large rocks and that these structural features are strongly selected by geckos (e.g., Morney, 1990; Schlesinger and Shine, 1994). Although Leaf tailed geckos in the field are rarely found under rocks (pers obs.) my results with the Leaf tailed gecko support the notion that geckos prefer narrow parallel crevices. The results also indicate that the Leaf tailed gecko selects crevices that are slightly larger than the minimum width into which they could fit. This is probably advantageous as it allows the gecko freedom to move and also provides room for their characteristic defensive posture of raising their body and wiggling the tail. The preferred crevice widths still enable the gecko to puff itself up effectively wedging itself in the crevice, which appears to be a last resort strategy.

Another possible benefit of selecting a slightly larger crevice may be to accommodate gravid females as it has been suggested that exclusive retreat site occupancy, as found in this study, infers territoriality and prolonged site tenure (Schlesinger and Shine, 1993). The finding of exclusive retreat site occupancy is generally supported by observations in the wild although it should be noted that *Phyllurus platurus* is known to have communal egg laying sites (Swan & Ehman, 1996).

It was surprising to find that leaf tailed geckos showed no preference for wet versus dry crevices. This result is in contrast with Green (1973) who found that Leaf tailed geckos retreated deeper into crevices during wet weather. The finding that Leaf tailed geckos prefer to be lower to the substrate does not conform to observations in the wild where Leaf tailed geckos are often found at considerable heights above the ground. Schlesinger and Shine (1994) noted a similar contrast in height preferences with *Oedura lesueurii* in captive versus wild observations. The authors suggested that this may have been a result of the geckos encountering more low lying crevices whilst moving about at night. However the finding that Leaf tailed geckos showed no preference with crevice orientation is supported by observations in the wild. In my sample there was sexual dimorphism with the females being longer on average, as previously shown by Doughty and Shine (1995). The finding that male *Phyllurus platurus* can fit into smaller crevices is supported by Doughty and Shine (1995) who found that females have thicker abdomens than the males.

In summary it appears that the Leaf tailed geckos assess width and shape as well as the presence of conspecifics before choosing a diurnal retreat site. Determining habitat preferences of species dependent on rocky retreat sites in Hawkesbury sandstone areas is of particular value as considerable areas of this habitat have been disturbed. This has mainly been a result of urbanisation and other developments often being carried out on ridge tops. Bush rock collecting has also degraded some of this habitat (Schlesinger and Shine, 1993). Although *Phyllurus platurus* has successfully adapted to many urban areas, others have done less well. For example it has been proposed that bush rock collecting may cause a decline in the numbers of *Oedura lesueurii* (Schlesinger and Shine, 1994) Although this species may also use deep

crevices (Schlesinger and Shine, 1994), my findings that *Phyllurus platurus* favours similar types of crevices and is also territorial, coupled with the fact that it can prey on small *Oedura lesueurii* (Ehmann, 1992) suggest the latter may have difficulty competing for retreat sites in deep crevices. The research here thus has implications for the survival of *Oedura lesueurii*, and consequently the endangered Broad Headed snake for which it is an important prey species, in disturbed sandstone habitats.

ACKNOWLEDGMENTS.

REFERENCES

Cogger, H.G. 1994, Reptiles and Amphibians of Australia. Reed Books, Sydney.

Doughty, P. and Shine, R. 1995, Life in two dimensions: natural history of the southern leaf tail gecko, *Phyllurus platurus*. Herpetologica, 51(2) 193-201.

Ehmann, H. 1992, Encyclopedia of Australian Animals. Reptiles. R. Strahan (Ed). Angus and Robertson, Sydney, N.S.W, Australia.

Green, D. 1973. Observations of the southern leaf tail gecko *Phyllurus platurus* (Shaw). Herpetofauna 6(2):21-24.

Greer, A.E, 1989. The Biology & Evolution of Australian Lizards. Surrey Beatty & sons, Chipping Norton.

Morey, S.R, 1990. Microhabitat selection and predation in the Pacific Tree Frog *Pseudacris regilla*. Journal of Herpetolology 24:292-296.

Schlesinger, C.A., and Shine, R, 1994, Choosing a rock: Perspectives of a commercial bush-rock-collector and a saxicolous lizard. Biological Conservation 67:49-56.

Schlesinger, C.A. and Shine, R. 1994, Selection of diurnal retreat sites by the nocturnal gekkonid lizard *Oedura lesueurii*. Herpetologica, 50(2):156-163.

Shine, R., and Fitzgerald, M. 1989. Conservation and reproduction of an endangered species: The broad headed snake *Hoplocephalus bungaroides* (Elapidae). Australian Journal of Zoology (25) 65-67.

Swan, G., and Ehmann, H. 1996. Communal egglaying in the broad-tailed gecko (*Phyllurus platurus*). Herpetofauna 26 (2):35-36.

HEMMED IN ON ALL SIDES? THE STATUS OF THE RESTRICTED GECKO, *NEPHRURUS DELEANI*

John Read
3D Eyre Ct., Roxby Downs,
South Australia, 5725.

INTRODUCTION

A number of Australian reptile species have small ranges (Cogger 1992), which are limited by climatic, biotic or habitat factors. Species with restricted ranges are particularly vulnerable to threatening processes such as vegetation clearance and overgrazing by domestic livestock, which are considered to be the principal factors endangering Australia's rare or threatened reptiles (Cogger et al. 1993).

The Pernatty Knob-tailed Gecko, *Nephrurus deleani*, is apparently restricted to a patch of sand-dunes immediately north and west of Pernatty Lagoon in central South Australia (Harvey 1983). *Nephrurus deleani* is a recently described and restricted member of its genus, which is a widespread and conspicuous element of the Australian arid-zone herpetofauna. Populations of *N. deleani* have been recorded from within the range of *N. levis*, but are geographically isolated from the closely related *N. stellatus*, which is common in mallee areas south of the Gawler Ranges (Galliford 1981, Harvey 1983) and *N. laevissimus*, which is found in the sand-dune deserts to the north-west of the *N. deleani* range. *Nephrurus* are entirely nocturnal, terrestrial and oviparous and feed on a variety of invertebrate and small vertebrate prey. Whilst the function of the distinctive knob on their tail is unknown, the profuse array of sensilla on its surface suggest an environmental monitoring role through detection of mechanical stimuli (Russell and Bauer 1987).

Due to its restricted distribution and perceived threats from overgrazing by rabbits and domestic stock, soil compaction and erosion, *N. deleani* is considered to be vulnerable and at risk fr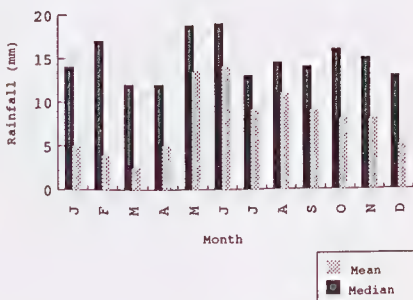om threats which could cause it to become extinct in the future (Cogger et al. 1993). This study aimed to determine the geographic distribution of *N. deleani*, to identify the factors limiting its range, and to assess the principal threats to the species. Data are also presented on morphometrics, markings, habitats and diets.

Study Region

Nephrurus deleani has been recorded from sand dunes fringing playa lakes to the south of Woomera, approximately 400km north of Adelaide. These lakes are fed by small streams which channel runoff from elevated gibber tablelands. The gibber tablelands are predominantly vegetated by low, perennial chenopod shrubs, whereas the sand dunes support a more structurally diverse assemblage of tall shrubs and low trees. The average mean rainfall at Oakden Hills Station, in the core of the *N. deleani* range, is 177.9mm with a median annual total of 163.2mm. Rainfall is generally slightly higher and more consistent in winter months compared to summer months (Fig. 1).

Figure 1. Mean and median monthly rainfall for Oakden Hills Station (1879-1995).

Average monthly rainfall Oakden Hills

METHODS

A total of 21 localities in the vicinity of known *N. deleani* locations were visited from 1991 to 1996. Geckos were searched for by spotlighting on foot for at least 8 hrs at each location and by supplementary limited pitfall trapping at several sites. The landform and dominant vegetation were recorded from all localities where either *N. deleani* or *N. levis* were recorded. Museum records and sightings from other herpetologists of both *N. deleani* and *N. levis* were also compiled to define the known range of both knob-tailed gecko species in the study area.

All captured animals were measured, sexed and kept overnight in calico bags in order to collect scats. Scats were subsequently hydrated and investigated under a dissecting microscope to ascertain dietary items. Adult females were visually inspected for eggs which were measured through the stomach wall.

Gravid specimens have also been recorded in January, April, May and October (Delean and Harvey 1984).
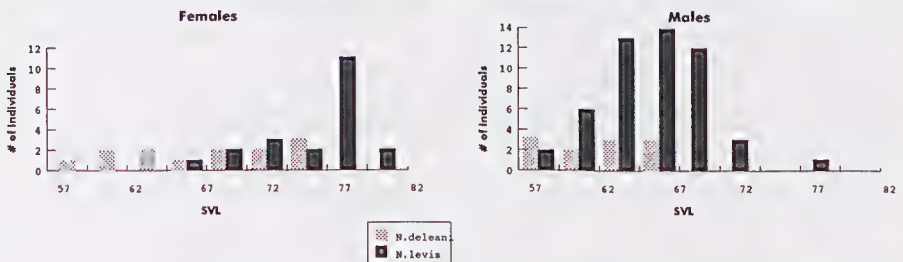
Markings

Dorsal patterning in *N. deleani* exhibited considerable variation (Harvey 1983) but usually consisted of one, or a combination, of the following features: a pale vertebral stripe, a broken dark paravertebral pair of stripes or two pale V-shaped marks on the neck. Contrary to the findings of Delean and Harvey (1984), the pale vertebral stripes were not restricted to juveniles.

Range

This study considerably increased the known range of *N. deleani* to the sand-dunes to the east, north and west of Pernatty Lagoon, south of Lake Windabout, the south-eastern shore of Island Lagoon, west of Ironstone Lagoon and the eastern shore of Lake McFarlane (Fig. 3). The northern and eastern extremities of the *N. deleani* range are clear-

Figure 2. Snout-vent length distributions of live female and male *N. deleani* and *N. levis*. SVL measurement (mm) is midpoint of 5 mm range

RESULTS

Morphometrics and Reproduction

A total of 35 *N. deleani* were captured from 1991 to 1996. Sex ratios were equal and females were generally larger than males (Fig. 2). Eight females exceeded 73mm SVL, peaking at 87mm, whereas the largest male measured 72mm. The size distribution of both sexes was considerably smaller than *N. levis* (Fig. 2). A gravid female with 2 x 25mm oviducal eggs was captured in late January and juveniles were recorded in February.

ly demarcated by the abrupt termination of occupied sand dunes into gibber tableland but the southern and south-western boundaries are less distinct as the sand dunes merge with densely vegetated sandy-loamy plains of the Hesso Environmental Association of Laut et al. (1977). Interestingly, although the distribution of *N. levis* completely encircles the range of *N. deleani*, these species were never recorded in sympatry (Fig. 3). Over one hundred *N. levis* but no *N. deleani* have been captured north of 31°10' S in the Moondiepitchnie dune system

(Read unpubl.), the next major dunefield defined by Laut et al. (1977) to the north of the recorded *N. deleani* range.

Habitats

Nephrurus deleani, which was previously considered to be restricted to Acacia vegetated dunes (Harvey 1983), was recorded from a diverse range of sand-dune vegetation types: including *Zygochloa* hummock grasslands; *Dodonaea viscosa*, *Acacia ligulata* and *A. burkitti* shrublands; and *Alectryon oleofolius*, *Acacia aneura*, and *A. ramulosa* woodlands (Table 1). Two individuals were recorded from bare sand regions and an adult male was recorded from *Atriplex vesicaria* shrubland at the base of a dune. Despite less intensive searching in other habitats, *N. deleani* were not recorded remote from sand dunes. Sand colour at the *N. deleani* localities varied from white or pale yellow adjacent to some of the lakes, to yellow-orange at sites more remote from the lakes.

All of the occupied habitats are widespread in regions adjoining the range of *N. deleani* and are all inhabited elsewhere by *N. levis* (Read 1992, Read unpubl.). Indeed, *N. levis* were captured from the northern and southern shores of Island Lagoon in very similar sand and vegetation types to those where *N. deleani* were recorded from the margin of this same lake.

Although most common near the shores of salt lakes where sand dunes tend to be best developed, *N. deleani* was not restricted to shore environments. Three individuals were recorded 14km south of Lake Windabout. Rabbits were evident at all localities and some sites carried high densities of either sheep or kangaroos. Whilst none of the *N. deleani* localities are protected within reserves, much of the foredune habitat adjoining Island Lagoon and Lake McFarlane is fenced off from domestic stock.

Diet

Analysis of scats of 5 adult and 2 juveniles suggest that *N. deleani* is an unspecialised invertebrate predator, although scorpions and spiders may be important in their diet (Table 2). One individual which had consumed a *Lychas* scorpion was dug from an enlarged scorpion hole, which may indicate that *N. deleani* may actually dig for their prey as well as capturing active prey on the surface.

Table 1. Dominant plant species at each *N. deleani* locality.

Dominant plant species	Number of N. deleani captures
Zygochloa paradoxa	12
Acacia ligulata	7
Dodonaea viscosa	6
Alectryon oleofolius	2
Acacia burkitti/Duboisia hopwoodi	2
Bare ground	2
Nitraria billardieri	1
Acacia ramulosa	1
Atriplex vesicaria	1

Table 2. Number of individual *N. deleani* recorded feeding on particular prey items through scat analysis.

Prey type	Number of *N. deleani*
Scorpion	4
Spider	3
Cockroach	2
Ant	2
Grasshopper	1
Beetle	1
Bug	1
Termite	1

DISCUSSION

The known range of *N. deleani* is considerably greater than previously recognised. Within its range *N. deleani* occurs throughout most sandy habitats and is apparently relatively abundant at some sites. However, this species is still considered to be restricted to a relatively small series of sandy regions in central South Australia. Assessment of the factors limiting the range of *N. deleani* are considered to be integral to determining the conservation status of this species. I will first assess a range of factors to establish their likely role in limiting *N. deleani* distribution. Then I will speculate upon a mechanism which could explain the most likely scenario accounting for this limited range which will enable the generation of hypotheses which can be tested with future work. Finally, the status of *N. deleani* will be discussed in the light of this new information and theories.

Potential range limiting factors

The distribution of *N. deleani* is probably not primarily limited by habitat restrictions, as they are found in a wide variety of sand-dune habitats. Similar habitats, in which the species was not found, are available nearby. Widespread vegetation clearance has not occurred within or adjacent to their range and hence is not responsible for their limited range. Pastoralism is also unlikely to have a significant impact, since where present in pastoral country, *N. deleani* can be abundant, including at the site near the eastern shore of Pernatty Lagoon (Fig. 3) which was degraded by sheep. Likewise, due to their longterm coexistance with rabbits which were abundant within and beyond the study area, habitat degradation by rabbits, is unlikely to be primarily responsible for the limited range of *N. deleani*.

Limited food resources are apparently not primarily responsible for restricting *N. deleani* to their present range. Along with arachnids which were common prey items in this study, *Rhynchoedura ornata* and *Diplodactylus damaeus* are widespread and common beyond the range of *N. deleani* (Read 1992, pers. obs), where they are important in the diet of *N. levis* (Pianka 1986, Drury 1995, Read unpubl. data). Although no geckos were recorded as prey in this study, Harvey (1983) reported that *N deleani* preyed extensively upon these geckos.

Although predators probably significantly reduce their dispersal success through habitats which afford little protection, predation levels on *N. deleani* are unlikely to be greater on dunes immediately outside their range than those within their range. The most significant native predators of knob-tailed geckos in central South Australia are goannas, snakes (pers. obs) and possibly owls, with the common species of each of these groups widespread and common throughout the region and hence unlikely to be able to restrict geckos to particular dunefields. Likewise, *Nephrurus* are also taken by cats and foxes (J. Read unpubl. data) but these exotic predators are also widespread throughout the southern Australian arid zone.

The southern Lake McFarlane *N. deleani* records were separated from other known populations, or suitable habitat, by at least 30 km and populations on the north-eastern

shore of Island Lagoon were also separated from occupied dunes by a salt lake or gibber plain. Therefore, extant populations have presumably partially penetrated the barrier of unsuitable habitats that were believed to isolate them from congenerics (Wilson and Knowles 1988). Since *N. deleani* can apparently disperse at least 30km through largely unfavourable habitat, the absence of these species from suitable dunes within 20km of the most northerly *N. deleani* records suggest that factors other than dispersal limitations are likely to be important in limiting their present range.

The available data suggest that *Nephrurus deleani* and *N. levis* occupy parapatric ranges and are mutually exclusive. Both species are most commonly found in sandy habitats and feed on a range of invertebrate and small lizard prey. Furthermore, the western margin of the *N. deleani* range approaches the range of both *N. laevissimus* and *N. stellatus* (Cogger 1992), which may limit their distribution to the north-west and south-west respectively. Although carefully designed experimentation is required to confirm this relationship, I will assume that interspecific competition between *Nephrurus* species is the most plausible primary reason for the limited distribution of *N. deleani*. Since the *N. levis* range abuts and encircles the known range of *N. deleani*, the relationship of these two species will be explored in detail.

Judging by their catholic habitat utilisation and widespread range over much of arid Australia, *N. levis* are arguably well equipped for dispersal. Although individuals have been recorded on gibber plains, chenopod shrublands and sand plains several kilometres from dunes (J. Read unpubl. data), dunes are favoured by *N. levis* in the absence of congeners (Reid 1988, James 1994, Read 1995). However, when sympatric with *N. laevissimus*, *N. levis* predominantly occupies interdunal swale habitats while *N. laevissimus* is largely restricted to dunes (Storr et al. 1990, Kerle 1993). Abundance of large invertebrates is typically higher on sand dunes than swales

(Dickman 1996) and hence *N. levis* apparently is competitively disadvantaged in the most favoured habitat.

Just as *N. levis* does not displace *N. laevissimus* from sand dunes, *N. levis* probably have not displaced *N. deleani* because the latter is better adapted to, and established, in the region. How then can *N. deleani* outcompete *N. levis* in only a relatively small region of unremarkable habitat, whereas it is apparently disadvantaged in surrounding areas? A series of biological and climatic factors which may interact to explain this conundrum are proposed.

Speculated mechanism for interspecific competition

Habitat or distributional segregation by sand-dwelling *Nephrurus* may be influenced by their differing tail morphology. *Nephrurus deleani*, like *N. laevissimus*, have narrow tails compared with the broad tails of *N. levis*. The importance of tails to *Nephrurus* is demonstrated by their reduced autonomy frequency (Russell and Bauer 1987), despite the advantages conferred upon geckos through tail autonom (Arnold 1988). Gecko tail form and functions are adaptable and subject to natural selection (Vitt et al. 1977) and hence it is not surprising that marked differences in tail morphology may reflect structuring in gecko communities.

Gecko tails, like those of insectivorous mammals (Morton 1978, 1980) tend to be larger and fatter in more arid and variable environments (Cogger 1957, Greer 1989), where over half of the bodies fat reserves may be stored in the tail (Vitt et al. 1977, Daniels 1984). Stored lipids may be particularly useful during droughts when food availability is low (Bustard 1967), during winter dormancy (Derickson 1976) or for enhancing juvenile viability (Arnold 1988) and vitellogenesis (Derickson 1976, Dial and Fitzpatrick 1981). Lipid storage is most important in environments with long droughts when food is scarce, or long cold periods when gecko activity is limited.

Given the advantages of large tails in desert geckos, why do *N. deleani* and *N. laevissimus* have slender tails? Although this question can not be answered with conviction, two possible explanations are proposed. Firstly, slender-tailed *Nephrurus* species may be able to partition more resources into reproduction or predator avoidance than species which are predisposed to fat storage. Secondly, slender tails may be a more effective lure. Tail movements are apparently used by *Nephrurus* (Swan 1990) and other reptiles (Pough 1988) to lure prey. Undisturbed *N. deleani* have been observed wiggling their tails, presumably for this purpose. Since slender tails are both more mobile and presumably more closely resemble prey items than broad, less flexible tails, they may enhance foraging success.

Diagnosis of the unique characteristics of the *N. deleani* range is simplified by making the assumption that *N. deleani* is restricted to optimal sand-dwelling *Nephrurus* habitat, whereas *N. levis* occupies less favourable adjacent regions. The 'prime' region would be expected to have more reliable, abundant or accessible resources than less preferred regions. Productivity and invertebrate abundance in semi-arid and and areas are primarily influenced by rainfall (Whittaker 1970, Bell 1985). Since total rainfall and rainfall reliability generally increase to the south and west in and South Australia it is not surprising that none of the slender-tailed *Nephrurus* species occupy the extremely arid sand-dune deserts immediately north or east of the *N. deleani* range. On the other hand, mean monthly temperatures decrease along a north-south gradient. *Nephrurus* are most active on warm summer nights (Drury 1995, pers obs.) and they can neither hunt nor digest prey during prolonged periods of cold weather during winter. *Nephrurus levis* may therefore be competitively advantaged to the south of the *N. deleani* range because it can make use of extensive lipid reserves for maintenance and vittelogenesis during the slightly longer cold periods which limit activity.

Some form of biological interaction, such as competition, is typically required to maintain allopatric boundaries which coincide with climatic clines (Key 1982). Relatively slight competitive advantages in some years may be reinforced because established species may exclude ecologically similar immigrant species (Lack 1976) and migrant animals may experience a lower survival rate than residents (Massot et al. 1994). Where dispersal is slow, such as might be the case where *Nephrurus* only reach isolated sand habitats occasionally, weak interactions will be sufficient to maintain parapatry (Bull 1991). Therefore, the competitive advantage of different tail morphology in particular climatic regimes, may be sufficient to reinforce the parapatric exclusion between the congeners.

Status of *N. deleani*

If *N. levis* can be demonstrated to be competitively disadvantaged within the range of *N. deleani,* the latter is probably relatively secure within its existing range and is presently not seriously threatened by the encroachment of *N. levis*. However, since direct and indirect effects of climate change may potentially alter the distributions of species (Stott 1994, Dexter et al. 1995), the ability of *N. deleani* to both persist and to outcompete *N. levis* may depend on the maintenance of current climatic conditions.

Central Australian mean temperatures are predicted to change by 0.5-2.5°C and rainfall timing and intensity may also change considerably within the next few decades (CSIRO 1992). Such a change in climate could not only effect *N. deleani* predation rates, activity times, fecundity, growth rates and resistance to disease (Adolph & Porter 1993), but also upset the finely balanced status quo that may have established between the two *Nephrurus* species. Since the distribution of *N. deleani* is confined to disjunct patches of suitable habitat, changes in its postulated competitive advantage with *N. levis* will not necessarily be buffered by migration from a core population and hence the species' distributions may change relatively rapidly.

Detailed research, which was beyond the scope of this study, are required to confirm whether *N. deleani* is indeed parapatrically separated from other *Nephrurus* through competition. Replicated transects through the margins of the *N. deleani* range, along with experimental trials of competitive success under different food abundance and climatic regimes may be necessary. If parapatry due to competition is confirmed, routine surveys for the presence or absence of *Nephrurus* in key habitats at the extremities of the current range of *N. deleani*, would provide a simple measure of the status of this restricted gecko.

ACKNOWLEDGMENTS

REFERENCES

Adolph, S.C. and Porter, W.P. 1993. Temperature, activity, and lizard life histories. Am. Nat. 142: 273-295.

Arnold, E.N. 1988. Caudal autonomy as a defense. Ch. 3 in: Biology of the reptilia. Volume 16: Defense and life history. Eds. C. Gans and Huey, R.B., Alan R. Liss, New York.

Bell, H.L. 1985. Seasonal variation and the effects of drought on the abundance of arthropods in savanna woodland on the Northern Tablelands of New South Wales. Aust. J Ecol. 10: 207-22 1.

Bull, C.M. 1991. Ecology of parapatric distributions. Annu. Rev. Ecol. Syst. 22: 19-3 6.

Bustard, H.R. 1967. Gekkonid lizards adapt fat storage to desert environments. Science 158: 11971198.

Cogger, H.G. 1957. Investigations in the gekkonid genus *Oedura* Gray. Proc. Linn. Soc. New South Wales. 82:167-79.

Cogger, H.G. 1992. Reptile and amphibians of Australia. Reed Books, Sydney.

Cogger, H., Cameron, E., Sadlier, R. and Eggler, P. 1993. The action plan for Australian reptiles. Australian Nature Conservation Agency, Canberra.

Congdon, J.D., Vitt, L.J. and King, W.W. 1974. Geckos: adaptive significance and energetics of tail autonomy. Science 184:1379-1380.

CSIRO 1992. Climate change scenarios for the Australian region. Climate Impact Group, CSIRO Division of Atmospheric Research, Mordialloc, Victoria.

Daniels, C.B. 1984. The importance of caudal lipid in the gecko *Phyllodactylus marmoratus*. Herpetologica 40: 337-344.

Delean, S. and Harvey, C. 1984. Notes on the reproduction of *Nephrurus deleani* (Reptilia: Gekkonidae). Trans. Roy. Soc. S. Aust. 108: 221-222.

Derickson, W.K. 1976. Lipid storage and utilization in reptiles. Am. Zool. 16: 711-723.

Dexter E.M., Chapman, A.D. and Busby, J.R. 1995. The impact of global warming on the distribution of threatened vertebrates (Environmental Resources Information Network, Canberra).

Dial, B.E. and Fitzpatrick, L.C. 1981. The energetic cost of tail autonomy to reproduction in the lizard *Coleonyx brevis* (Sauria: Gekkonidae). Oecologia 51: 310-317.

Dickman, C.R. 1996. Vagrants in the desert. Nature Australia 25: 54-62.

Drury, R. 1995. The physiology and behaviour of a nocturnal desert gecko, *Nephrurus levis*. Unpubl. Honours Thesis, University of Sydney.

Galliford, M. 1981. Notes on the Starred Knob-tailed Gecko *Nephrurus stellatus*, caught spotlighting. Herpetofauna 12: 33-34.

Greer, A.E. 1989. The biology and evolution of Australian lizards. Surrey Beatty, Sydney.

Harvey, C. 1981. A new species of *Nephrurus* (Reptilia: Gekkonidae) from South Australia. Trans. Roy. Soc. S. Aust. 107:231-235.

James, C.D. 1994. Spatial and temporal variation in structure of a diverse lizard assemblage in arid Australia. Ch. 13 in: Lizard Ecology: Historical and experimental perspectives. (Eds Vitt, L.J. and Pianka, E.R.) Princeton University Press, Princeton, New Jersey.

Kerle, J.A. 1993. Historical survey of the vertebrate fauna in the vicinity of Uluru and Kata Tjuta. Kowari 4: 6-27.

Key, K.H.L. 1982. Species, parapatry, and the morabine grasshoppers. Syst. Zool. 30: 425-58.

Lack, D. 1976. Island biology illustrated by the land birds of Jamaica. Blackwell Scientific Publications, Oxford.

Laut, P., Kseig, G., Lazarides, M., Laffier, E., Margules, C., Scott, R.M. and Sullivan, M.E. 1977. Environments ofSouth Australia. CSIRO Division of Land Use Research,Canberra.

Massot, M., Clobert, J., Lecomte, J. and Barbault, R. 1994. Incumbant advantage in common lizards and their colonizing ability. J Anim. Ecol. 63: 431-440.

Morton S.R. 1978. An ecological study of *Sminthopsis crassicaudata* (Marsupialia: Dasyuridae) III. Reproduction and life history. Aust. Wildl. Res. 5: 183-211.

Morton S.R. 1980. Ecological correlates of caudal fat storage in small mammals. Aust. Mamm. 3: 8186.

Pianka, E.R. 1986. Ecology and natural history of desert lizards. Princeton University Press, Princeton. New Jersey.

Pough, F.H. 1988. Mimicry and related phenomena. Ch 2. in: Biology of the reptilia. Volume 16: Defense and life history. Eds. C. Gans and Huey, R.B., Alan R. Liss, New York

Read, J.L. 1992. Influence of habitats, climate, gazing and mining on terrestrial vertebrates at Olympic Dam, South Australia. Rangel. J 14: 143-56.

Read, J.L. 1995. Subhabitat variability: A key to the high reptile diversity in chenopod shrublands. Aust. J Ecol. 20: 494-501.

Reid, J. 1988. Mammals, reptiles and frogs. In: The Coongie Lakes Study (Eds J. Reid and J. Gillen). Depaertment of Environment and Planning, Adelaide.

Richter-Dyn, N. and Goel, N.S. 1972. On the extinction of a colonizing species. Theoretical Population Biology 3: 406-433.

Russell, A.P. and Bauer, A.M. 1987. Caudal morphology of the knob-tailed geckos, Genus *Nephrurus* (Reptilia: Gekkonidae), with special reference to the tail tip. Aust. J Zool. 35: 541-5 1.

Storr, G.M., Smith, L.A. and Johnstone, R.E. 1990. Lizards of Western Australia III, Geckos and Pygopods. W.A.Museum, Perth.

Stott, P. 1994. Climate change and its implications for the terrestrial vertebrate fauna. Trans. R Soc. S. Aust. 118: 59-68.

Swan, G. 1990. A field guide to the snakes and lizards of New South Wales. Three Sisters Productions, Winmalee, NSW.

Vitt, L.J., Congdon, J.D. and Dickson, N.A. 1977. Adaptive strategies and energetics of tail autonomy in lizards. Ecology 58: 326-337.

Whittaker, R.H. 1970. Communities and ecosystems. Collier-McMillan, London

Wilson, S.K. and Knowles, D.G. 1988. Australia's reptiles: a photographic reference to the terrestrial reptiles of Australia. Collins, Sydney.

Figure 3. New *N. deleani* localities and *N. levis* localities from the current survey and museum records from the region including and adjacent to the known range of *N. deleani*.

A RANGE EXTENSION FOR THE SCRUB PYTHON *MORELIA AMETHISTINA* (SERPENTES: BOIDAE): A RECORD FROM MAGNETIC ISLAND, NORTH QUEENSLAND

Simon Fearn,
18 Olympus Crescent, Arcadia
Magnetic Island, Qld, 4819

The Australian distribution of *Morelia amethistina* comprises tropical north coastal Queensland and some Torres Strait islands. This species has been recorded from a variety of habitat types, but rainforest and adjoining habitats appear to be predominantly favoured throughout it's range (Barker & Barker, 1994). Barker and Barker (1994) record the southern most populations of *M. amethistina* occur in the vicinity of Mt. Spec, 80km north west of Townsville. Calvert (1996) extends the southern distribution through Herveys Range to Bluewater (30km north of Townsville) and one record from Townsville itself. Th author examined a male *M. amethistina* (SVL 2270mm, WT 1500g) captured at night crossing a residential/commercial street at Nathan Plaza, Aitkenvale in Townsville city on the 13th November 1998. Sullivan (pers. comm.), removed an adult *M. amethistina* from an urban situation at Alligator Creek, 20km south-east of Townsville. It appears that the southern most limits of *M. amethistina* distribution in Queensland have not been determined with precision.

The author records for the first time, the occurrence of *M. amethistina* on Magnetic Island (latitude 190º10' S, longitude 146º50' E) 8km across Cleveland Bay from Townsville.

At 12.15am on the 22/11/97 the author encountered a large adult *M. amethistina* crossing a walking track in mixed eucalypt woodland/ dry vine thicket forest at Nelly Bay. As such an encounter was unexpected, this very large specimen could not be safely captured for a photographic record and accurate data on the snakes dimensions could not be collected. However, sticks were pushed into the ground at the snakes extremities to determine approximate total length, which was

550cm with a mid-body girth of approximately 35cm.

It would seem remarkable that one of the worlds largest snakes could avoid official recognition on a 5184ha island that was settled by Europeans 130yrs ago (Barnes, 1997) and has a current resident population of some 2000 people. In addition, almost half the island is National Park, where presumably, faunal surveys have been conducted.

The possibility that the observed specimen of *M. amethistina* was an introduction or an escaped captive appears highly unlikely, as several island residents interviewed by the author reported encountering very large pythons up to 450cm in length crossing roads at night. Such observations are consistent with the presence of *M. amethistina*.

The reptile fauna of Magnetic Island is diverse and poorly documented in a limited literature. Low (1978) records 32 species of lizards and snakes, however this species list contains several errors and a number of omissions (Shea, 1987., authors obs.). Shea (1987) records the pygopid lizard *Delma labialis* and Valentic (1995) records the bluetongue lizard *Tiliqua scincoides*. Low (1978) records only one boid snake, *Anteresia maculosa* which is common on the island (authors obs.). Carpet pythons *Morelia spilota* are also present, but apparently in low densities (authors obs.).

Detailed ecological data on *M. amethistina* is limited (Calvert, 1996), with most data originating from captive specimens (Barker & Barker, 1994) and dissection of small numbers of museum specimens (Shine & Slip, 1990). Anecdotal data (particularly size records and spectacularly large prey items) are scattered throughout the literature. Food habits reportedly consist almost entirely of

mammals (Shine, 1991) up to the size of adult tree kangaroos *Dendrolagus bennettianus* (Flannery, *et al*, 1996), feral pigs *Sus scrofa* (Barker & Barker, 1994) and adult dingos *Canis lupus dingo* (Anon 1998).

The terrestrial mammal fauna of Magnetic Island is poor, with only 6 native species (brush-tail possum *Trichosurus vulpecula*, allied rock-wallaby *Petrogale assimilis*, koala *Phascolarctos cinereus*, echidna *Tachyglossus aculeatus*, water rat *Hydromys chrysogaster*, northern native cat *Dasyurus hallucatus*) and 3 introduced (black rat *Rattus rattus*, feral cat *Felis domesticus*, feral pig *Sus scrofa*) known to occur on the island. Of these, *D. hallucatus* is apparently extinct, *S. scrofa* is reported to have been successfully eradicated and *R. rattus* is restricted to urban areas and is present in low densities (Heinsohn, pers. comm.). The paucity of small to medium mammals (rodents, bandicoots) on the island may explain the apparent rarity of *M. amethistina* due to low recruitment of juveniles into the adult population. Further research may reveal that large adults are associated with rock-wallaby colonies on the granite boulder slopes of the islands interior. The food habits of hatchlings and juveniles in the wild are unknown (Calvert, 1996) and it would be unlikely that they predate entirely on mammals. The apparent absence of small native mammals on Magnetic Island may indicate a catholic diet, with an ontogenetic dietary shift from ectotherms to endotherms, commensurate with growth, typical of other *Morelia* spp. (Shine, 1991, 1994).

A detailed overview of known *M. amethistina* biology & habits is provided by Calvert (1996).

ACKNOWLEDGEMENTS

REFERENCES

Anonymous, 1998. Nature bites back. Townsville Bulletin, Friday 13, 1998. p4.

Barker, D. G. & Barker, T. M. 1994. Pythons of the world: volume 1, Australia. Advanced Vivarium Systems Inc. Lakeside, California.

Barnes, T. 1997. Peaceful isle: story of Magnetic Island from the 1860's. Gillingham Printers Pty Ltd. Underdale, South Australia.

Calvert, G. 1996. The amethystine python *(Morelia amethistina)*: a review of biology and habits. Chondro. The Cape York Herpetological Society journal, 4 (1). pp. 16-20.

Flannery, T. F., Martin, R. & Szalay, A. 1996. Tree kangaroos: a curious natural history. Reed Books, Sydney.

Low, T. 1978. The reptiles of Magnetic Island, nth Queensland. Herpetofauna 9 (2) pp. 10-14.

Shea, G. M. 1987. Two new species of *Delma* (Lacertilia: Pygopodidae) from northeastern Queensland and a note on the status of the genus *Aclys*. Proceedings of the Linnean Society of New South Wales 109: 203-212.

Shine, R. 1991. Australian snakes: a natural history. Reed Books, Sydney.

Shine, R. 1994. The biology and management of the diamond python *(Morelia spilota spilota)* and carpet python (*M. s. variegata)* in NSW. Species management report no. 15. NSW National Parks and Wildlife Service.

Shine, R. & Slip, D. 1990. Biological aspects of the adaptive radiation of Australasian pythons (Serpentes: Boidae). Herpetologica, 46. pp. 283-290.

Valentic, R. A. 1995. Occurrence of *Tiliqua scincoides* (Hunter 1790) on Magnetic Island, Queensland. Herpetofauna 25 (2).

BREEDING AND MATERNAL INCUBATION OF A DIAMOND PYTHON MORELIA SPILOTA SPILOTA (SERPENTES:BOIDAE)

Nicholas Watson
8 Oxford Road, Dapto
NSW 2530

INTRODUCTION

The Diamond Python *Morelia spilota spilota* is a relatively large snake reaching lengths of up to 2.5metres. The distribution of this species ranges from Victoria, along the south-east coast of NSW up to northern NSW. The Diamond Python is sympatric with the Carpet Python *Morelia spilota mcdowelli* in the northern parts of its range and hybridisation occurs as a result.

Females of most python species are known to coil tightly around their eggs during incubation and raise their body temperature by muscular contractions known as shivering thermogenesis (Slip and Shine, 1988; Barker and Barker, 1994). This enables them to heat their eggs during incubation, thus increasing the rate of development.Few published records of maternal incubation in diamond pythons exist with Harlow and Grigg (1984) and Slip and Shine (1988) being the only two I know of. The three pythons mentioned in this paper were all wild caught from Dapto, 15km south of Wollongong on the south east coast of NSW (34°33'S 150°48'E).

HOUSING

One male python with a snout-vent length (SVL) of 1.4metres was kept with two females; one 1.6 and one 1.8m SVL. They were housed together in an outdoor avairy with dimensions 5m x 2m x 2m, containing hollow logs, plants, a pond, branches, hiding boxes and a leaf litter ground. The roof is made from sheets of galvanised iron which when heated by the sun provide the pythons with their main heat source. The cage wire is cov-ered by green shadecloth. Temperatures within the cage can reach 40°c on hot days and fall to 9°c during winter nights. The hiding boxes are lined on the inside with sheets of polystyrene 15mm thick which offer some degree of insulation from temperature extremes. A skylight of clear plastic in the roof allows the pythons to bask in full sunlight. Some herpetologists believe that this species will not breed if both sexes are kept together all year round. However this was not the case in my experience as these snakes were put together in January and mated in August.

MATING OBSERVATIONS

The first observed mating was between the male and the larger female on August 29, 1997. The mating took place in a hiding box situated 1metre above the ground. They mated from the afternoon until late in the evening. I observed a second mating on September 30, 1997. They both mated in the same hiding box as before and at no time did the male show any interest in the smaller female. I observed no further courtship or mating behaviour by the male after this date.On October 23, 1997 the reproductive female had a midbody swelling presumably from ovulation as described by Barker and Barker (1994). They record the pre-egglaying shed being 21-25 days before egg-laying, however this female shed her pre-egglaying skin 31 days before egglaying. From this moment onwards the female was observed basking in the mornings and then returning to a hiding box where she would rest coiled upside down with her ventral scales exposed.

NESTING AND EGGLAYING

On December 22, 1997 the female laid 24 eggs in a hiding box situated on the ground and in the most cool and shaded part of the cage. One egg appeared infertile but remained adhered to the egg pile. It was 3.5cm long and 2.0cm wide and solid. On January 8, one egg had become detached from the egg pile and was outside the females coils. It was placed with the other eggs in the hope that it was still viable but soon turned yellow and slimy so was discarded. On cloudy days the female was seen to use shivering thermogenesis for the entire day and throughout the evening. When days were warm, with a temperature of 20-25'c, she would only shiver during the evening. On hot days the temperature within the hiding box could reach 30'c and shivering was never observed on these days. Most mornings and occasionally during the afternoon she would leave the clutch to get warm against the heated roof This would take around 20-30 minutes and sometimes she would leave the eggs to re-heat herself as many as four times a day. She was also observed shivering as she lay stretched out basking. When she returned to the eggs she would coil around them and turn them slightly clockwise by using muscular "waves". Each coil would turn idependently starting with the bottom coil and the "waves" or "ripples" would travel along the body ending at the neck. By the end of each week the clutch had rotated a full 360'. This rotating of the egg mass continued until hatching. By late January she had become extremely thin and loose skinned. On February 2, 1998 she was offered a large defrosted mouse which she ate while remaining on the eggs. During February she appeared to shiver less, as hatching became closer. She also started coiling more loosly around the eggs as opposed to the tight coils she applied in the early stages of incubation. On February 12, 1998 the female entered another "opaque" stage of skin shedding and became a lot more aggressive. By now the eggs had become a lot smaller; they appeared to have shrunk during incubation.

They were also wrinkled and creased, and started to take on a brownish colour but otherwise seemed in good condition. In the late evening of February 14, 1998 three hatchlings were observed with their heads out of their eggs. The female investigated the hatchlings with repeated tongue flickings but didn't leave the egg pile. The next morning several more babies were coming out of their eggs. The clutch was removed from the female and placed in a glass tank to allow hatchlings to emerge.

The first hatchling to emerge died a few hours later. Prior to its emergence its egg was seen covered in ants feeding on the egg fluids oozing from the slit. It is possible the ants forced the hatchling out before it was ready. After the eggs were removed from the mother they began to dry out so I slit the top surface of the few remaining unhatched eggs. By February 17, the last of the pythons had hatched after an incubation period of 54 - 57 days. The female remained inside the hiding box for a further week and continued to shiver before finally leaving.

HATCHLINGS

The hatchlings shed their first skin between March 3 and March 17, 1998. They began to feed from March 16 to March 30 1998. They were offered defrosted newborn mice (pinkies) which were excepted reluctantly. Over the weeks they began to dislike the pinkies and steadfastly refused them unless they were first scented with the Garden Skink *Lampropholis guichenoti* or the Grass Skink *Lampropholis delicata*. Before long they refused even the scented pinkies and would only take live skinks, never dead ones. One hatchling escaped and when recaptured several weeks later was found to have a medium sized Eastern Water Skink *Eulamprus quoyii* in its stomach. Unfortunately the sex of the hatchlings was not determined. See table I for details of the hatchlings.

ACKNOWLEDGEMENTS

REFERENCES

Barker, D.G. and Barker, T.M 1994 Pythons of the World. Volume I:Australia, Advanced Vivarium Systems, Inc.California

Harlow, P. and Grigg, G.C., 1984 Shivering thermogenesis in a brooding Diamond Python, *Python spilotes spilotes*. Copeia 1984:959-956.

Slip, D.J. and Shine, R., 1988. Reptilian endothermy: a field study of thermoregulation by brooding diamond pythons. Journal of Zoology 216:367-378.

Table 1. Hatchling data of *M.s.spilota*.

	SVL (mm)	TL (mm)	WEIGHT (g)
Mean=	355.7	416.5	16.5
SD=	18.6	17.6	1.0
Range=	310-385	375-455	14.2-18.0
N=	22	22	22

NOTES ON CAPTIVE REPRODUCTION
IN THE PYGMY PYTHON *ANTARESIA PERTHENSIS*

Brad Maryan
169 Egina Street, Mount Hawthorn 6016

Bruce George
5 Euro Place, Gosnells 6110

INTRODUCTION

The Pygmy Python *Antaresia perthensis* is the smallest python in the world and endemic to Western Australia (Barker and Barker, 1994). Even though it is common few people keep it in Western Australia due to restrictive state legislation that all but prohibits amateur herpetoculture (Knowles *et al*, 1991;Hoser, 1993 & 1996). To our knowledge only two observations of captive reproduction are available and both occurred outside W.A. One is an unpublished record from Hoelzel (Barker and Barker, 1994) and Hoser (1981, 1992 & 1995) provides the only detailed breeding record along with other information.

As stated in Barker and Barker (1994) it is one of the least known of the pythons in captivity and in the wild. As long term private resident herpetologists in this state we were very keen to keep and breed A. *perthensis*. Under present Department of Conservation and Land Management (CALM) Policy Statement 22, reptile keeping licences are only issued to those who wish to conduct a research and/or scientific project. Working on this premise we submitted an application for a licence to maintain and breed this species on 27 September 1996 with support references from two research scientists. However, to date, we have not received a response from CALM. The following captive reproductive record in this species was documented in the interim.

UNSUCCESSFUL CLUTCH

The parent male and female came from the Pilbara region and upon introduction on 14 August 1996 weighed 83g and 159g respectively. Prior to this the male was subjected to a 'cooling off' period of 2-3 months. Hoser (1992) relates his breeding failures with this species to year round heating. The male was introduced on and off until 28 October when it was noticed the female was swollen posteriorly and egg laying was imminent. Unfortunately no copulation was observed. The female was seen once in the inverted 'belly up' position on 29 October. On 6 November six healthy looking eggs were laid and immediately removed. Measurements and weights are as follows:

33 X 21mm, 8.0gm   33 X 19mm, 8.0gm
32 X 19mm, 7.0gm   37 X 19mm, 8.0gm
36 X 19mm, 8.0gm   19 X 12mm, 4.0gm

The females weight after oviposition was 104gm allowing a reproductive effort of 44.7 % to be calculated following Bush (1997). The previously recorded egg clutch size for A. *perthensis* is 2-5 (Hoser, 1995). The female was tightly coiled around the eggs when discovered but as mentioned by Kend (1997) no actual thermal shivering was observed. It was probably warm enough already as the eggs were deposited inside a hide box on a heat pad. Unfortunately on 19 November all 6 eggs developed a severe mould infestation and turned green. They were discarded.

SUCCESSFUL CLUTCH

Again in 1997 the same male was 'cooled ' as described previously then gradually warmed until his introduction to two females on 23 September. The second female came from the Pilbara region. Female 1 who laid the previous clutch was 138gm and Female 2 160gm at the time. The females were housed separately with male being intermittently introduced to

them, particularly after sloughing. This was continued until 13 November when it was noticed that Female 1 was very swollen posteriorly. She deposited five eggs (Fig 1) the following day which were immediately removed for artificial incubation. Pre and post-egglaying sloughs occurred 26 and 20 days respectively. Unfortunately eggs 2-5 were strongly adhered together and incubated as a combined mass. The larger clutch size of 6 and 5 may account for the smaller egg measurements in this study compared to Barker and Barker (1994) who report a length range of 35-44mm. Eggs were placed on a mix of 100gm Vermiculite/50gm water (2:1 ratio) and incubated at 30deg C. The weight of Female 1 after oviposition was 93gm (reproductive effort: 35.5%) and just prior 136gm. She also ate nothing during this period suggesting that accumulated fat reserves were enough for egg production after insemination. Again no copulation was observed. Hoser (1992) seemed to experience the same secretive copulatory behaviour in which the mating snakes immediately separated upon disturbance. Based on our limited experiences this seems to be in direct contrast to most other species which remain oblivious to one's presence when mating.

All eggs hatched between 2-5 January 1998 after 50-53 days incubation (Fig 1). After pipping the hatchlings were extremely secretive, immediately retracting their heads into the egg when disturbed, and not providing any opportunity to secure a photograph with head sticking out. It seemed that when ready to leave the egg they emerged rapidly. The hatchlings are very well patterned having dark brown blotches and bars on a lighter brown ground colour. The ventral surface is pinkish. Postnatal sloughs in this clutch occurred 11-13 days after hatching. Female 2 failed to produce a clutch.

**Figure 1: Egg and hatchling data for *Antaresia perthensis*
Note that combined mass of eggs 2-5 was 30.7gm.**

	EGG		HATCHLING		
	Measurements	Weight	Total length	Tail length	Weight
1	34 X 17mm	7.5gm	196mm	19mm	3.7gm
2	39 X 17mm	See above	203mm	19mm	4.5gm
3	35 X 16mm	" "	202mm	20mm	4.5gm
4	33 X 17mm	" "	204mm	20mm	4.6gm
5	31 X 17mm	"	198mm	21mm	4.3gm

REFERENCES

Barker, D.G. and Barker, T.M. 1994. Pythons of the World Volume 1, Australia. Advanced Vivarium Systems Inc., California USA 171pp.

Bush, B. 1997. Captive Reproduction in the South-Western Carpet Python *Morelia spilota imbricata*, including an exceptional fasting

record of a reproductively active female. Herpetofauna 27 (2): B-12.

Hoser, R.T. 1981. Australian Pythons (Part 2) The Smaller *Liasis*. The Herptile 6 (3): 13-19.

Hoser, R.T. 1992. Search for the Ant-Hill Python *Bothrochilus perthensis* (Stull, 1932). Litteratura Serpentium (English Edition) 12 (1): 13-19.

Hoser, R.T. 1993. Smuggled - The Underground Trade in Australia's Wildlife. Apollo Books 149pp.

Hoser, R.T. 1995. The Ant-Hill Python from Western Australia. Reptiles Magazine 3 (5): 10-16.

Hoser, R.T. 1996. Smuggled 2 - Wildlife Trafficking, Crime and Corruption in Australia. Kotabi Publications 259pp.

Knowles, D.G., Maryan, B. and Browne-Cooper, R. 1991. The Role of the Amateur Herpetologist in Western Australia. Herpetofauna 21 (1): 1-4

Kend, B.A. 1997. Pythons of Australia. Canyonlands Publishing Group, Utah USA 206pp.

ERRATA
RECENT RECORDS OF THE GIANT BURROWING FROG
(HELEIOPORUS AUSTRALIACUS) FROM THE FAR SOUTH COAST OF NSW

It has been brought to my attention that there was a factual error presented in this paper (published in volume 28 (1)). This involved the statement that the last documented sightings were those of Lunney and Barker, 1986, and Webb, 1987 and 1991a. In fact, a record for this species, obtained in Wandella State Forest, was documented by Richard Wells and Ross Wellington in 1994. This was a result of a survey conducted by them in the Narooma area for State Forests of NSW. I acknowledge this mistake and they deserve full credit for making the first sighting after the early 1980s.

This was an unintentional error. I should have used the word published instead of docu-mented and was really referring to the Eden area in this sentence, but this was not stated. The record by Wells and Wellington was certainly not deliberately ignored nor was it included in this paper under another name. I apologise on behalf of myself and the other authors for any distress caused by this error.

Wellington, R. C. and Wells, R. W. 1994. A Report on reptiles and amphibians observed in the Narooma forestry district. Wandella-Dampier State Forests. Report prepared for State Forests NSW.

Frank Lemckert

NOTES ON REPRODUCTION IN CAPTIVE
DELMA GRAYII (LACERTILIA: PYGOPODIDAE)

Brad Maryan, 169 Egina Street, Mount Hawthorn 6016 W.A.

The pygopodid lizard *Delma grayii* Smith is endemic to the west coast and hinterland of south-western W.A. (Bush *et al*. 1995). Maryan (1984) provided some information on this species in the Perth region. The maximum recorded total length is up to 545mm (Ehmann, 1992). Although some reproductive data has been documented for *D. australis* and *D. fraseri* from SW Western Australia (Bush, 1983), none is available for *D. grayii*.

On 25 November 1997 a female *Delma grayii* (SVL=115mm) with regenerated tail was pit-trapped among open Melaleuca heathland at Modong Nature Reserve (32° 14' S, 115° 53' E) and retained until oviposition on 30 November. The clutch of 2 eggs

was immediately weighed/measured (Table 1) and incubated at 30°C on 2 : 1 ratio vermiculite/water (by weight). The weights of the female before and after oviposition were 14gm and 11gm respectively. *D. grayii* has been observed copulating in captivity during October (T. Pattison; pers. comm.).

On 24 January 1998 egg 2 hatched and the other on the following day after 61-62 days incubation. Hatchlings were extremely active after leaving their egg cases, performing typical *Delma* leaps to evade capture. Dorsal colouration was similar to adults (Bush *et al.* 1995); ventrally chin and throat was yellow and the bellies creamish. The hatchlings weights and measurements are presented in Table 1.

Table 1. Egg and hatchling data for Delma grayii.

EGG			HATCHLING		
Length/Width	Weight		SVL	TL	Weight
1. 26.5 X 10	1.6gm		44mm	151mm	0.9gm
2. 29 X 10	1.5gm		44mm	150mm	0.9gm

ACKNOWLEDGEMENTS

REFERENCES

Bush, B., 1983. A Record of Reproduction in Captive Delma australis and D. fraseri (*Lacertilia: Pygopodidae*). Herpetofauna 15 (1): 11-12.

Bush, B., Maryan, B., Cooper-Browne, R. and Robinson, D., 1995. A Guide to the Reptiles and Frogs of the Perth Region. University of W.A. Press. 226pp.

Ehmann, H., 1992. Encyclopedia of Australian Animals - Reptiles. Angus & Robertson.495pp.

Maryan, B., 1984. *Delma grayii* Smith In an Urban Area near Perth, Western Australia. Herpetofauna 16 (1): 29.

A RECORD OF *NEOBATRACHUS* FROM THE CESSNOCK AREA OF NSW.

Frank Lemckert

Native Forest Management Systems, Forest Research and Development Division, State Forests NSW, P.O. Box 100 Beecroft, NSW. 2119

The genus *Neobatrachus* consists of ten species of burrowing frogs which are generally associated with the more arid areas of inland Australia (Barker et al, 1995). Three of these species are known to occur within N.S.W., but this genus is apparently absent from the more mesic coastal lands east of the great dividing range (Cogger, 1992; Barker et al, 1995). In 1993, a site in Cessnock State Forest (AMG 348500 6368600) was surveyed as a prelude to its use as a research site for the application of biosolid wastes. This survey included the placing of small preservative filled pitfall traps across the site to catch insects, but which also caught several species of frogs. On examination of these specimens one was noted to be a *Neobatrachus* sp. The specimen keyed out to *Neobatrachus sudelli* (using Cogger, 1992), which is the species closest in distribution to the area. Presumably this is its correct identity, however the isolated nature of this record does raise the potential that it represents a new taxa. Regardless, this is a range extension for this genus into the coastal plain of NSW.

The area in which this frog was collected is covered with a regenerating dry open *Corymbia maculata* (spotted gum) and *Eucalyptus fibrosa* (red ironbark) woodland. The understorey was also very dry and open and consisted of a scattering of species including *Melaleuca strypheloides* (prickly paperbark), *Macrozamia communis* (burrawang), *Oxylobium ilicifolium* (native holly), *Themeda triandra* (kangaroo grass) and *Imperata cylindrica* (bladey grass). The soils of the area are skeletal with a heavy clay subsoil and have poor drainage and low fertility (FCNSW, 1993). Rainfall averages 900mm and temperatures vary from a winter mean minimum of 6 degrees to a mean summer high of 30 degrees. This site had been the subject of moderate disturbance in that it has been regularly burnt (at least prior to the survey) and had been rela-

tively heavily logged during the 1970s. It is also adjacent to the Cessnock rubbish tip and so may have been affected by water run-off from the tip. Other species of frog collected included *Limnodynastes ornatus* (ornate burrowing frog), *L. peronii* (striped marsh frog), *L. tasmaniensis* (spotted grass frog), *Crinia signifera* (common eastern froglets) and *Uperoleia sp.* (toadlets).

The presence of this frog may be explained by the geography of the Hunter Valley which forms a corridor of dryer vegetation extending from the dividing range to the coast. This corridor may have enabled this frog to extend its range onto the eastern side of the great dividing range which is an area not normally occupied by this species. If so, surveyors should keep in mind this group of frogs when performing surveys in the Hunter Valley or any such similar areas. A return to the site certainly would be worthwhile to establish if a population is still present and obtain material for genetic analysis.

ACKNOWLEDGMENTS

REFERENCES

Barker, J., Grigg, G. C. and Tyler, M. J. 1995. A Field Guide to Australian Frogs. Rigby, Adelaide.

Cogger, H. G. 1992. Reptiles and Amphibians of Australia (Revised Edition). Reed. Sydney, NSW.

FCNSW. 1993. Experimental design for the application of sewerage sludge to *Eucalyptus maculata/fibrosa* regrowth forest. Unpublished report for the Sydney Water Board.

PREDATION ON A RIDGE-TAILED MONITOR (*VARANUS ACANTHURUS*) BY A PYGMY PYTHON (*ANTARESIA PERTHENSIS*).

Robert Browne-Cooper,
24 Wotan Street, Doubleview WA 6018

INTRODUCTION

The Pygmy Python (*A.perthensis*) preys on reptiles and mammals (Shine 1991). Specific prey items documented by Shine and Slip (1990) include geckos, skinks and small mammals identified from the guts of dissected Pygmy Pythons. Hoser (1981) mentions small marsupials (*Antechinus sp*) as prey. In addition, two small mammals were recorded from the gut of a road-killed Pygmy Python from the Burrup Peninsula in January 1997 (Browne-Cooper, pers obs).
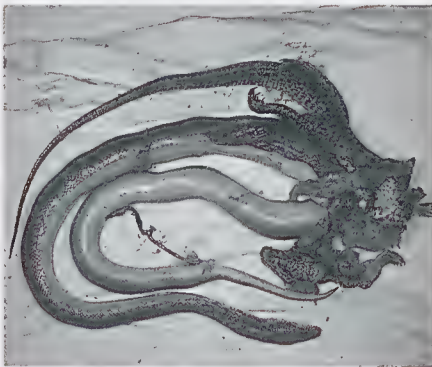
OBSERVATION

On 26th May 1998, while on a fauna survey of the Burrup Peninsula (20°40'S 116°44'E) for the Department of Conservation and Land Management, Bruce George, Brad Maryan and I were road spotting along the few kilometres of bitumen road of the peninsula.

We collected a fresh road-killed Pygmy Python (*A.perthensis*) with total length about 45cm, and we noted that it had consumed a small Ridge-tailed monitor (*V.acanthurus*) with a total length of about 25cm (see figure 1) The adjacent habitat at this site is typical of much of the Burrup Peninsula being hummock grass on very rocky iron stone substrate.

REMARKS

This observation is an addition to the prey species recorded for *A.perthensis*, although it is possible that this is an example of road-kill predation. However, given the lack of varanid activity noted due to cool weather during this field trip, I suspect that this was natural predation. In any case, it suggests that this python, like several other Australian Boids, is quite an opportunistic feeder in the wild.

Figure 1. Photograph of road-killed Pygmy Python (*A.perthensis*) with gut contents - a Ridge-tailed Monitor (*V.acanthurus*).

ACKNOWLEDGMENTS

Thanks go to Brad Maryan for his comments on this field note.

REFERENCES

Barker,D.G. & Barker,T.M. 1994. Pythons of the World. Volume 1, Australia. First Ed. Advanced Vivarium Systems Inc. California. USA

Cogger, H.G. 1992. Reptiles and Amphibians of Australia. Revised Edition. Reed Books Pty Ltd. Sydney.

Hoser, R.T. 1981. Australian Pythons, part 2, the smaller *Liasis*. The Herptile. 6(2):10-16.

Shine, R. 1991. Australian Snakes A Natural History. Reed Books. Pty Ltd. Sydney.

Shine, R. & Slip, D.J. 1990. Biological Aspects of the Adaptive Radiation of Australian Pythons (Serpentes:Boidae). Herpetologica. 46(3):283-29

NOCTURNAL ACTIVITY IN CAPTIVE VARANID LIZARDS

Adam Jones
c/o Australian Herpetological Society
PO Box R79, Royal Exchange Sydney NSW 2000

Nocturnal activity has been documented in a number of varanid lizards in the field. Feeding is the likely reason for a record of nocturnal activity in *Varanus panoptes* (Irwin *et al.* 1996). Fyfe (1980) has recorded *V. tristis* feeding at night, in this case near lights outside a building and *V. glebopalma* has been recorded, foraging after sunset, by two authors, Christian (1977) and Shea *et al.* (1988). Another instance of nocturnal activity was recorded by Valentic (1995), when he witnessed an adult *V. spenceri* alert and positioned in an upright stance late at night on the Tablelands Highway (N.T.), possibly having been disturbed by a heavy rain storm. Here I document two cases of captive varanids held in the Sydney region being active during the night.

On 26 October 1997, at 19:08 hours, loud scratching noises were heard coming from an outside enclosure housing an immature (93cm total length) Lace Monitor, *V. varius*. Upon investigation using torch light, the lizard was observed moving about the enclosure, finally coming to rest upon a log within which it usually shelters. The lizard, previously unaware of my presence, took fright once the torch light was purposefully directed onto it, and retreated into the log. Each of the four dead mice left in the enclosure late that afternoon had been consumed by this time, although it cannot be ascertained whether they were consumed after sunset. Neither the day temperature, nor the night temperature seemed unusually high for the spring period, though no temperature records were taken.

The other record of nocturnal activity involves *V. acanthurus* housed in indoor accommodation. On a number of occasions throughout the night, during the months of August and September 1997, the *V. acanthurus* have been heard digging beneath the rock slabs used by the lizards for shelter. The digging is vigorous enough to throw the gravel substrate up against the walls of the enclosure, producing a noticeable level of noise. Again no records of temperature were taken, though the nights didn't seem unusually warm for this time of year. No *V. acanthurus* were witnessed moving openly about the enclosure after dark during the months of August and September.

However on 19 February 1998 at 22:45 hours, the male *V. acanthurus* was witnessed moving about the front of the enclosure. The room was dimly illuminated by a single lamp which was turned on at 22:40 hours, however at this time the lizard was not observed active. Early the same day a nesting box was introduced into the enclosure, and potential courtship activities witnessed between the *V. acanthurus* (the male lizard chasing the female and biting her around the neck region). Since the lizard was not active when the lamp was initially turned on, it may be possible that the room light was sufficient to evoke a waking response and subsequent activity in the lizard. This explanation however is tentative, as no other reptiles kept in the same room exhibited any activity subsequent to the room lamp being switched on. No later episodes of nocturnal activity were witnessed on subsequent nights, even when the room lamp was similarly switched on. It may be possible that the male *V. acanthurus* was more easily disturbed due to its greater degree of activity, secondary to the recent courtship activities.

REFERENCES

Christian, T. 1977. Notes on *Varanus glebopalma*. Vict. Herp. Soc. News. 6:11-13.

Fyfe, G. 1980. Notes on the black-headed monitor (*Varanus tristis*). Herpetofauna 12:15.

Irwin, S., Lyons, B. and Frisby, T. 1996. Nocturnal activity by *Varanus panoptes* at Cape Melville. Herpetofauna 26 (2): 50.

Shea, G., Weigel, J., Harwood, A., Floriani, H., and Hemsley, C. 1988. Notes on the herpetofauna. of the Mitchell Plateau, Western Australia. Results of the 1987 Australian Herpetological Society field trip to the Kimberleys. Herpetofauna 18 (1): 9-20.

Valentic, R.A. 1995. Further instances of nocturnal activity in agamids and varanids. Herpetofauna 25 (1): 49-50.

BOOK REVIEW

Bennett, R. 1998. *Reptiles and Frogs of the Australian Capital Territory.*
National Parks Association of the ACT Inc., Woden , ACT; 86 pp.

Allen E. Greer, The Australian Museum, 6 College St, Sydney, NSW 2000

The success or failure of the conservation movement rests on how much humans value nature. And one of the fundamental emotional links between humans and other organisms arises when a person recognises an organism in the field. A bond is formed, and the well-being of the organism and its kind thereafter becomes intertwined, to greater or lesser extent, to the observer's own well-being. The closer we come to other organisms, physically, and the more we know about them, the stronger our bond with them becomes. Hence anything that helps build that important tie between people and other species helps conservation. One of the primary aids in building that tie are field guides such as the one Ross Bennett has written for the reptiles and frogs of the Australian Capital Territory. In fact, in providing an easy to use guide for an area that is frequented by a lot of well educated but busy people, he may have made the single most important contribution of the conservation of reptiles and frogs in the ACT that one private individual can make.

The guide is of the 'flip through the pictures until you find the one that looks like the one you've seen' genre. This approach is feasible as there are relatively few species in each of the local major herpetofaunal groups: one tortoise, 40 lizards, eight snakes and 18 frogs (the latter including one locally extinct and two completely extinct species). There is a novel addition to the guide, at least as far as herpetology goes. This is the use of a line pointing to the salient feature on each species' colour photograph that will certify the identification of the species. This line begins at a brief description of the character such as 'conspicuously small eye' to one side of the image and ends on the character itself, in this instance the eye. Hence one knows exactly what salient features to look for to confirm the first impression created by the photograph. The photographs are all of good to excellent quality, and some, such as the distinctly coloured juvenile *Varanus rosenbergi*, appear to be 'firsts'.

In addition to a colour photograph, there is also parallel information on the general appearance and size, distribution, habitat and habits for each species. Each of the family groups also gets a brief overview as do the even more inclusive groups - reptiles, lizards, snakes and frogs. There is also a brief introductory discussion of the general environment of the ACT and of the current conservation regulations controlling the collection and holding of reptiles and frogs in the ACT. There is also a very general bibliography and an index. All in all, it is a very useful and well designed 86 pages.

Field guides such as these highlight how dependent we are on the biological 'infrastructure' provided by basic taxonomy. Without having a formal scientific name based on a properly crafted scientific description, plus other basic distributional and biological information that is all part of good basic taxonomy, no other aspect of learning or indeed, even appreciation, gets very far. In fact, one might even go so far as to say that without having passed through the formal taxonomic process, a species hardly exists, at least for most purposes of western culture. So we thank Ross Bennett sincerely for having compiled this charming and important little field guide. But while toasting him, spare a small thought for those few obsessed, pointed-headed taxonomists beavering away in museums and other learned institutions that gave birth, at least intellectually, to those species in the first place. Without them, we wouldn't have anything to talk about.

BOOK REVIEW

Patrick David & Gernot Vogel *The Snakes of Sumatra*.
An annotated checklist and key. Edition Chimaira, Frankfurt am Main. 260pp.

Glenn M. Shea, Department of Veterinary Anatomy & Pathology
University of Sydney NSW 2006

The fauna of Indonesia has long been of special interest to zoologists due to the collision of different biogeographic regions. However, knowledge of Indonesian biodiversity has remained poor due to the difficulties faced by collectors, both in the past and present. Snakes follow the same pattern as other groups: a greatly scattered literature of locality records and taxonomic papers, few data on habitat preferences or ecology, and few modern systematic studies. The most recent complete guide to the Indonesian snake fauna is Volume 2 of Nelly de Rooij's *The reptiles of the Indo-Australian Archipelago* (1917), long out of print and very much out of date.

To partially fill this vacuum, David and Vogel have compiled this checklist and key to the snakes of Sumatra, to which they append notes on distribution and ecology. While the book must be considered preliminary in that it does not involve much field research and does not fully revise the fauna, it provides the valuable service of drawing together the extensive yet scattered literature and highlighting problem areas, in preparation for the next generation of field and laboratory herpetologists. Hopefully, it will be as stimulating in this respect as the first edition of Cogger's *Reptiles and Amphibians of Australia* was to herpetologists of the day.

The Snakes of Sumatra opens with a brief historical introduction to Indonesia and its present political divisions, a geographical description of Sumatra and a history of discovery of the Sumatran snake fauna. Individual species are then covered, with an attempt to list all relevant literature on Sumatran populations of the species. Each species account includes any known data on ecology and distribution. Sadly, although there are 127 snake species recorded for Sumatra, with 22 endemic to the island, 41 species are known from Sumatra from only one or two specimens or localities. A few black and white drawings of generally good quality, mostly of heads, accompany some accounts.

Following the species accounts is a preliminary key to all species and subspecies recorded from Sumatra, a block of eight pages of colour plates (four or five illustrations per plate), illustrating a few species and habitats, a summary (in English, French and German) of the few nomenclatural and taxonomic decisions made in the volume, and an extensive bibliography and gazetteer of localities.

While the book will be of great use to future workers, I was disappointed by three features. Firstly, the almost complete lack of morphological data. Although the authors explain that much of this would simply be repeating what has previously been published, it would still have been useful to incorporate. Secondly, although type localities and original references are included, the current repository and registration number for type specimens could have been included with little extra effort. Finally, David and Vogel follow the trend in several recent guides to exclude sea snakes, although they do include homalopsines and other aquatic species. These complaints aside, this book is a worthy addition to any herpetological library.

Daniel Bennett, *Monitor Lizards: Natural History, Biology & Husbandry*.
Edition Chimaira, Frankfurt am Main

Glenn M. Shea Dept of Veterinary Anatomy & Pathology
University of Sydney NSW 2006

Goannas, known to the rest of the world as monitor lizards, must surely have the most devoted and parochial following of fans of any group of reptiles. For a family which has fewer than 50 species, all placed in a single genus, the volume of popular literature on goannas is beyond belief. In the last decade, five new books on varanids of the world have appeared (Sprackland, 1992; Bennett, 1995; Steel, 1996; Kirschner *et al.*, 1996, Eidenmüller, 1997), together with a reprint of Mertens' classic three part monograph of the family. There have been four entire volumes devoted to single species (Auffenberg, 1981, 1988, 1994; Lenz, 1995), and entire symposia on monitors (e.g., Böhme & Horn, 1991). Australia, with the majority of the world's monitors, has also jumped on the bandwagon (Green & King, 1993).

The present volume is a revised and expanded version of Bennett's original spiral bound paperback *A Little Book of Monitor Lizards*. As explained in the preface by Wolfgang Böhme it arose because of a desire for a German edition of Bennett's work, which in turn led to calls for an English edition of the German revision. In its new form, this book is to my mind the best of the world compendia on monitors. Opening with introductory chapters covering nomenclature, evolutionary history, anatomy and physiology, ecology, the interrelationships between monitors and man, and monitor husbandry and breeding, which together fill the first quarter of the volume, the main bulk of the book consists of species accounts. For each species, a distribution map, list of recognised subspecies, and details of distribution, habitat, ecology and husbandry are provided, although no general species descriptions are provided. The species accounts are accompanied by a pro-

fusion of black and white and coloured photographs, from a variety of photographers. The photographs are generally of good quality, although several are poorly focused. Most species are illustrated in colour with whole animal, head profile and juvenile photographs, when available, although in some cases of well-known species, this amounts to almost overkill: there are ten photographs of *V. tristis*, although monitor enthusiasts will probably salivate over every one. However, more judicious selection of photographs would have enabled some of the better quality photographs to be reproduced at larger size. The book closes with an extensive (32 p.) bibliography (including a number of little-known references and theses), a brief list of important herpetological societies and journals, and a series of climatic figures (rainfall and temperature) for 42 representative localities from areas inhabited by varanids.

Inevitably, given the diversity of opinion among monitor enthusiasts, there are some surprises for Australian-based readers. Bennett lists three subspecies for *V. acanthurus*, although only two are generally recognised here. He adopts the nomenclatural conclusions proposed by Böhme (1991) regarding the *V. gouldii* complex, although these have found little acceptance in Australia, and accepts the growing recognition of *Varanus keithhornei* as the available name for the Cape York member of the *V. prasinus* complex.

More depressing for the Australian-based reader is the predominance of non-local literature on husbandry and breeding. The vast majority of reports of captive reproduction of Australian species are from outside Australia. For example, Bennett lists eight papers on

reproduction of *V. acanthurus*, reporting up to fourth generation captive breeding, none based on local efforts. This should be treated as a challenge to Australian herpetoculturists. There are plenty of goanna enthusiasts in Australia, and there is clearly a market for captive-bred stock. This book is a valuable guide to the literature on how it can be done.

REFERENCES

Auffenberg, W. 1981. The Behavioural Ecology of the Komodo Monitor. University Presses of Florida, Gainesville (406pp.)

Auffenberg, W. 1988. Gray's Monitor Lizard. University Presses of Florida, Gainesville (419pp.)

Auffenberg, W. 1994. The Bengal Monitor. University of Florida Press, Gainesville (561 pp.)

Bennett, D. 1995. A little book of monitor lizards. Viper Press, Aberdeen (208pp.)

Böhme, W. 1991. The identity of *Varanus gouldii* (Gray, 1838), and the nomenclature of the *V. gouldii*-species complex. Mertensiella (2): 38-41.

Böhme, W. & Horn, H.-G. 1991. Advances in monitor research. Mertensiella (2): 1-266.

Eidenmüller, B. 1997. Warane - Lebensweise. Pflege.Zucht. Offenbach.

Green, B. & King, D. 1993. Goanna. The Biology of Varanid Lizards. University of NSW Press, Sydney (102pp.)

Kirschner, A., Müller, T. & Seufer, H. 1996. Faszination Warane. Kirschner & Seufer Verlag, Kelten-Weiler (254pp.)

Lenz, S. 1995. Zur Biologie und Okologie des Nilwarans, *Varanus niloticus* (Linnaeus 1766) in Gambia, Westafrika. Mertensiella (5): 1-256.

Sprackland, R.G. 1992. Giant Lizards. TFH Publications, Neptune, New Jersey. (288pp.)

Steel, R. 1996. Living dragons. A natural history of the world's monitor lizards. Blandford, London.(160pp.)

LETTER TO THE EDITOR

DON'T FEED FIREFLIES TO HERPS

Recent studies with lizards have demonstrated that ingestion of fireflies (or "lightning bugs", as they are sometimes called) can kill lizards and, thus, should be considered potentially toxic to all herps. Three cases have been documented. One inland bearded dragon (*Pogona vitticeps*) died within an hour of eating several fireflies. Another *Pogona vitticeps* died about two hours after eating a single firefly. A leopard chameleon (*Chamaeleo pardalis*) died shortly after eating half a dozen fireflies.

Fireflies of the genus *Photinus* contain protective poisionous steroids called 'lucibufagins' which are believed to be responsible for the deaths. Not all fireflies naturally contain these toxins, but others (*Photuris*) can acquire toxicity by feeding on *Photinus*. Thus, all fireflies should be avoided. lucibufaginsare related chemically to cardenolides which are potently cardiotonic and at very low dosages can cause death in mammals. These toxins are manufactured by a number of plants, including milkweed plants, on which many insects (such as certain lygaeid bugs, and monarch and queen butterflies) feed. Thus, it would be wise to exclude all such insects from the diets of lizards and other herps, pending further studies.

Additional information can be obtained from an article just submitted fro publication by scientists at Cornell University, the National Animal Poison Control Center, and Trinity College. The manuscript can be viewed on the web: http://www.bio.cornell.edu/neurobio/eisner/pogona.html

Correspondence address:

Kraig Adler
Neurobiology and Behaviour
Seeley G. Mudd Hall
Cornell University
Ithaca New York 14853-2702

Phone   607 254 4392
Email   kka4@cornell.edu
Fax   607 254 4308

NOTES TO CONTRIBUTORS

Herpetofauna publishes articles on any aspect of reptiles and amphibians. Articles are invited from interested authors particularly non-professional herpetologists and keepers. Priority is given to articles reporting field work, observations in the field and captive husbandry and breeding.

All material must be original and must not have been published elsewhere.

PUBLICATION POLICY

Authors are responsible for the accuracy of the information presented in any submitted article. Current taxonomic combinations should be used unless the article is itself of a taxonomic nature proposing new combinations or describing new species.

Original illustrations will be returned to the author, if requested, after publication.

SUBMISSION OF MANUSCRIPT

Two copies of the article (including any illustrations) should be submitted. Typewrite or handwrite (neatly) your manuscript in double spacing with a 25mm free margin all round on A4 size paper. Number the pages. Number the illustrations as Figure 1 etc., Table 1 etc., or Map 1 etc., and include a caption with each one. Either underline or italicise scientific names. Use each scientific name in full the first time, (eg *Delma australis*), subsequently it can be shortened (*D. australis*). Include a common name for each species.

The metric system should be used for measurements.

Place the authors name and address under the title.

Latitude and longitude of any localities mentioned should be indicated.

Use the Concise Oxford Dictionary for spelling checks.

Photographs – black and white prints are preferred but colour slides are acceptable.

Use a recent issue of *Herpetofauna* as a style guide.

A computer disc may be submitted instead of hard copy but this should not be done until after the manuscript has been reviewed and the referees' comments incorporated. Computer discs must be HD 1.44 mb 3.5" in Word for Windows; Wordperfect; Macintosh or ASCI. Any disc must also be accompanied by hard copy.

Articles should not exceed 12 typed double spaced pages in length, including any illustrations.

REFERENCES

Any references made to other published material must be cited in the text, giving the author, year of publication and the page numbers if necessary. At the end of the article a full reference list should be given in alphabetical order. (See this journal).

Manuscripts will be reviewed by up to three referees and acceptance will be decided by an editorial committee. Minor changes suggested by the referees will be incorporated into the article and proofs sent to the senior author for approval.

Significant changes will require the article to be revised and a fresh manuscript submitted.

REPRINTS

The senior author will receive 25 reprints of the article free of charge.

Pletholax gracilis, the Javelin legless lizard from W.A.
See paper in this issue (photo by M. Bamford)

Delma grayii from Modong Nature Reserve, Oakford W.A.
See paper in this issue (photo by Brad Maryan)